SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

Beginning

Vol. V

JULY 1939

Contents

Front cover by Adrian Clem
Back cover by C. E. Margraff

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

526643

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 1 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON JULY • 1939

GIANT WILD-RYE IN THE CONSERVATION PROGRAM

By LOWELL A. MULLEN [1]

GRASS is man's most powerful ally in soil and moisture conservation. Its part in the scheme of things is fixed but has not as yet been fully developed. Because of certain innate qualities, some species are far superior to others for the given job. The jobs are numerous and varied and, consequently, a diversity of species and/or strains must be used if the conservation program is to reach its fullest development.

Proper plant management, in areas of good soils receiving 18 inches or more of rainfall, is now primarily a matter of additional refinement of practice rather than one of radical revision. Adapted plants and basic facts of practices are known. At present, however, one of the most challenging aspects concerning the use of grass in the conservation program involves the determination of species and proper management of plants especially adapted for use on the millions of acres where climatic and edaphic factors are less favorable for plant establishment but which in spite of this are of inestimable value for range rehabilitation. In many instances merely the establishment of a vegetal cover will serve in attaining the ultimate goal. In any event, the species of plants which can be used will be limited in number, and they must be known to have some very definite qualifications.

Elymus condensatus Presl., giant wild-rye, appears to be a very versatile species and consequently merits consideration for this work. This opinion is based on years of experience and notes taken by field men. The plant is so well known and so widely distributed that no general taxonomic discussion is necessary. The

Elymus condensatus *in February 1939, near Pullman, Wash.*

Range Plant Handbook, item G52, is an excellent reference for the outstanding characters and values of the species, but it does not discuss the very important matter of variation. Although some variation may be merely a reflection of site factors, there is evidence to indicate that several genetically different forms exist. This is possibly true, to some extent, for many native members of the Hordeae tribe. The species occurs throughout the Pacific Northwest from elevations of 700 feet in central Washington to 7,000 feet in southeastern Oregon. Sites range from Palouse bottomlands and sandy silts to basaltic talus and scablands. It frequently occurs in the dominant vegetation in alkaline flats and is commonly the most abundant grass associated with *Artemisia* on range lands. It is locally abundant along railroad rights-of-way, roadsides, and irrigation ditches. The rainfall varies throughout its range from 8 to 20 inches. No quantitative data are as

[1] Manager, seed and plant collection unit, section of conservation nurseries, Soil Conservation Service, Pullman, Wash.

yet available to show correlation between a given form and geographic distribution in this region. It seems likely that some correlation does exist.

Some common variations are: Height, 3 feet to 6 feet; color, green to bluish; leaves, ¼ inch to ¾ inch in width, rather lax to very stiff, almost glabrous to very scabrous; inflorescence, short and narrow (much like *E. glaucus*) to 10 inches long and ¾ inch in diameter; date of maturity; palatability, poor to excellent. (It is reported but not proved that some strains are more palatable than others.)

WHEN variation in site and plant characters are considered it seems logical to believe that ecological strains or varieties exist which, if properly segregated, might prove of value in conservation practice. Although reports from the field do not indicate the merit of a given plant type, they are most emphatic in stressing the value of the species. The following typical excerpts are taken from field reports and correspondence with ranchers:

". . . impressed by the amount of *Elymus condensatus* used for hay in this area. In some places it brings the same price per ton as *Poa nevadensis* and one rancher informed us that for horses at least it was superior to alfalfa. There appears to be a great deal of variation in this species and several selections have been made." [The area referred to is southeastern Oregon, in the Diamond-Crowley vicinity.]

". . . herd of 50 horses grazing this area did not touch this species (*P. secunda*) but limited their choice to *Elymus condensatus* and *Bromus tectorum*. . . . observations checked by watching the herd for half an hour . . . supports the suggestion of 1937 that *E. condensatus* belongs among the more valuable plants for the south Idaho desert.

"The question of stock grazing *E. condensatus* in Crazy Canyon, Oneida County, was discussed. Mr. ———, who works this area extensively, states that the stock wander back and forth three or four times a year to a distance of 8 miles from a source of water. Their forage is primarily *E. condensatus*, as previously recorded. [Other reports have indicated that stock feeding extensively on this grass can do without other water for considerable periods.]

". . . less harsh form of *E. condensatus* which reaches a height of 6 feet was sampled. . . . This species is ranked as one of the better forage plants for soil locally. In fact, it is in high enough esteem for the agency to make a special project for its selection and sowing on the reservation itself." [Duck Valley Indian Reservation, southwest Idaho and northeast Nevada.]

ONE of the most interesting discussions of giant wild-rye as a valuable range plant was sent in by a rancher in southeastern Oregon. This man and the situation are well known to the author. His comments are based on years of experience as a stockman: "For the better part of my life, I have been running stock (horses, cattle, and sheep) on this eastern Oregon desert. I believe I have had an opportunity to observe the value of grass . . . In the years past I have traveled into every nook and corner of the United States; into Canada and Old Mexico; and have nowhere seen such an abundance of grass and so many varieties as we have on our range here on Steens Mountain.

"Today (August 24) the first band of sheep came into one of our fields. I sat for an hour on a rock observing them as they fed past me, knowing that they always search the range for the best first, which, of course, would be the flowers, 'weeds' as the sheepmen call them, but I also noticed that they never passed up a bunch of the giant wild-rye. I saw as many as six around a single bunch and they did not leave it until the stalks were stripped bare of foliage. Only the heads that they could not reach were left for the deer and horses; and only anise did they seem to prefer to the rye. . . . I recall that at one time, in Barren Valley (Crowley) I was 'out' two head of cows. In the spring I found them, looking good, in a field that had been fed out in the fall; they had wintered in deep snow on the ryegrass stubs. I have seen this happen scores of times. In the early days, the great Harney Valley was the wintering grounds for the vast herds of cattle, and it was principally the ryegrass that wintered them.

"On my horse ranch in Barren Valley, years ago, the principal hay that I put up was ryegrass, to winter what few cattle and horses I had. Others did the same, as the cattlemen there are doing today. And this section is east of Steens Mountain, in the driest part of Oregon. I have seen bands of sheep come off the desert in the winter where they were dying by the hundreds, their skinned carcasses piled in ricks like cordwood, and the dying stopped immediately when they were fed the only available hay—ryegrass. From the standpoint of forage, based on my personal experience and observation, I believe ryegrass to be one of, if not the most valuable, all-around desert grass we have.

"It is a common sight, as one rides through this desert, to see a pile of blow dirt (topsoil) behind a ryegrass clump. A conspicuous example of this can be seen on the Crane-Diamond road . . . On the left of the road, on the slope of a small ridge, is the home of a very aged couple. It is apparent to me that they are a remnant of the 'stickers' who homesteaded most of Harney Valley some thirty years ago. Between their house and the road is a patch of ryegrass that is gaining yearly in elevation from the blow dirt it catches. I have been on this road when the wind was blowing the dust so thick that I was forced to stop the car to await better visibility. Surely this did not occur when old-time Harney Valley waved with ryegrass such as in this old man's field. When these old folks fenced the field there was no more ryegrass in it than there is now across the roadway—here and there a scattered bunch; but year after year the few bunches were allowed to seed, and the field was used for fall and winter pasture.

"And now, ryegrass and moisture conservation. Many times I have ridden around snowdrifts held by patches of ryegrass. When the snow is gone the patch of ryegrass will be perforated with sage-rat and badger holes where at the lower end they have puddled their cistern. As in summer the ryegrass clumps catch the dirt, in winter they catch the snow . . . I notice ryegrass along the streams and gulches, too, buffeting the swirling waters as it clings tenaciously to the banks."

All of these facts and comments prove nothing, but they very strongly indicate that *E. condensatus*, in one or more of its forms, has considerable promise for revegetating areas for which it is adapted. It is not only valuable as a forage and hay plant but also as plant cover to retard erosion and hold snow. It is potentially a heavy seed producer, although frequently the seed is not viable.

The greatest drawback to extensive use of this species is that it is very slow to become established. It is hoped that present observational plantings in this region will provide data for developing better cultural practices and for selecting strains which are superior in speed of establishment, in seed production, and in general utility.

SIDE-OATS GRAMA FOR EROSION CONTROL

By DONALD R. CORNELIUS [1]

SIDE-OATS GRAMA (*Bouteloua curtipendula*) deserves attention as a grass that will control erosion through central Oklahoma, Kansas, and Nebraska. It is valuable over a somewhat wider area in local situations. It is a native grass which will grow on rough, sloping, or rocky soil and will produce satisfactory forage for grazing purposes.

The distribution of side-oats grama includes 34 States, according to Hitchcock's Manual of Grasses. It has been reported on plains, prairies, and rocky hills from Maine and Ontario to Montana, south to Maryland, Alabama, Texas, Arizona, and southern California. In Kansas it is found in greater abundance through the central one-third of the State. It grows on rocky slopes with shallow soil of low fertility and in competition with other grasses on productive native meadows. A fibrous root system and fairly dense sod make this plant well adapted to holding the soil.

There was remarkable survival of side-oats grama through the droughts of 1934 and 1935. Many pastures observed throughout the eastern half of Kansas show a higher percentage of side-oats grama in relation to total grass plants per unit area than before the severe drought period. Unpublished data obtained by A. E. Aldous of the Kansas Experiment Station on pastures near Manhattan, Kans., show the following percentage of side-oats grama for the years 1927 to 1936.

Table 1.—*Number * of plants per square meter on grazed pastures near Manhattan, Kans.*

Year	Side-oat grama plants per square meter	Total grass plants per square meter	Percentage of total grass
1927	220	1, 746	12. 6
1928	263	1, 640	16. 0
1930	262	1, 380	19. 0
1932	321	1, 622	19. 8
1935	164	591	27. 8
1936	240	624	38. 4

* Average of about 70 permanent meter-square quadrants counted each of the 6 years included in the report.

THE PASTURES on which the experiment was conducted were grazed each year. The maximum number of plants of side-oats grama, 321 per square

[1] Junior agronomist, Soil Conservation Service nurseries, Manhattan, Kans.

meter, were found in 1932 following a series of favorable years. A severe drought in 1934 and 1935 reduced the number about 50 percent, but the total grass population was injured to even a greater degree with a reduction of 63 percent from 1932 to 1935.

Recovery of side-oats grama from effects of the drought was more rapid than for the other grasses, showing 46 percent and 6 percent increase, respectively, from 1935 to 1936.

A lack of seed is one of the principal reasons for the limited use of side-oats grama in revegetation work in the Plains section of the United States. Previous to the season of 1937, the only seed harvested in Region 7 was from small areas by hand labor. In August 1937 several hundred acres of meadows and lightly grazed pastures, in the vicinity of Lindsborg and Gypsum, Kans., produced a yield of seed sufficient to justify the use of grass seed strippers. A total of 693 acres of side-oats grama was harvested with an average yield of 32 pounds per acre, making a total of 23,190 pounds.

The season of 1938 was favorable for the production of side-oats grama seed on the native meadows and pastures of the eastern half of Kansas. More or less droughty conditions of the 4 preceding years had reduced the percentage of other species on the native prairie. Side-oats grama had increased in abundance so that at the time of seed production some areas appeared to be pure stands. The previous dry years had favored nitrate accumulation in the soil and with normal rainfall in 1938 conditions were favorable for a good yield of seed. Small combines were available and farmers harvested approximately 50,000 pounds of side-oats grama seed. Yields of 50 to 150 pounds per acre were reported.

WITH present harvesting and cleaning equipment side-oats grama seed usually has a very low percentage of purity when compared with other grass seed. Purity determinations giving the percent by weight of pure seed (the florets containing developed caryopses) in proportion to the total bulk of the material has ranged from 7 to 25 percent for the past 2 years. Inert material composed of empty glumes and florets, the rachis to which the florets are attached, and small pieces of stem or leaf, make up the greatest percentage of the bulk material harvested as seed.

Purity and germination reports for representative side-oats grama seed samples for 1937 and 1938 are given in table 2. The tests were conducted by Katie C. Kirkpatrick, regional seed analyst. There is considerable difference in the percentage of florets containing caryopses as given in the column headed "caryopsis count." The variation of 6.8 percent to 25.14 percent is reflected in the purity of the seed and appears to be one of the most important factors affecting purity. Under the heading "other seed," sand dropseed, *Sporobolus cryptandrus*, has been most common. Germination tests have been consistently low, approximately 25 percent at time of harvest, with an increase during the winter and spring until a germination of 60 to 70 percent is usually reached about planting time in the spring.

ALTHOUGH the purity expressed in percentage of weight is rather low, the number of seeds per pound of side-oats grama is not so much lower than many of our other common grasses. The samples given in table 2 average about 80,000 caryopses or seed per pound of bulk seed. Bromegrass has approximately 137,000 seeds per pound; big bluestem, 48,000 seeds per pound; perennial ryegrass, 223,000 seeds per pound; and meadow fescue, 240,000 seeds per pound.

The type of machinery for harvesting side-oats grama will depend somewhat upon the stand of grass to be harvested. In general, small combines are the most practical and are very satisfactory. Thin stands might be harvested more economically with grass seed

Table 2.—*Purity and germination of side-oats grama seed from various sources in Kansas, 1937 and 1938*

Accession number	Year harvested	Source	Caryopsis count	Pure seed	Inert matter	Other seed	Germination		Counts per pound of material	Counts per pound of pure seed	Method of harvesting and cleaning
							Percentage	Date			
KG-457	1937	Bridgeport, Kans	15.34	15.0	84.0	1.0	22.5 63.0	Oct. 29, 1937 Apr. 19, 1938	83,009	415,047	Cylinder strippers and fan mill.
KG-459	1937	Gypsum, Kans	18.60	23.50	73.25	3.25	22.0 69.5	Oct. 29, 1937 July 11, 1938	92,989	395,696	Do.
KG-482	1937	Increase plot, S. C. S. Nursery, Manhattan, Kans.	....	21.5	78.5	0	58.5	Mar. 17, 1938	101,833	473,646	Hand-stripped.
KG-773-1	1938	.....do	18.36	18.5	81.5	0	29.5	Sept. 23, 1938	107,503	581,102	Combine.
KG-1040	1938	Silver Lake, Kans	6.8	7.0	92.0	1.0	27.5	Oct. 10, 1938	37,422	534,603	Do.
KG-1041	1938	Alma, Kans	25.14	25.0	73.0	2.0	34.5	.....do	141,751	567,004	Grain binder and thresher.

Typical specimen of side-oats grama; from Lindsborg, Kans.

strippers, though this depends on the availability of combines and labor. Much of the side-oats grama in Kansas occurs with big bluestem, *Andropogon furcatus*. Combines tend to break the stems of bluestem grass, so that they are difficult to remove. In such instances, it may be better to cut the side-oats grama with a binder and thresh the bundles, when slightly moist with dew, in an ordinary threshing machine.

SEEDLING plants of side-oats grama are not rapid growers as are those of most native species. However, germination of the seed and strength of the seedlings has been very good at the Manhattan nursery. An increase plot of 2.06 acres was planted April 10, 1937, in 30-inch rows, cultivated, and weeded throughout the summer. Seed stalks were produced in August, and 679 pounds of seed were harvested in September 1937. A yield of 335 pounds of cleaned seed per acre was obtained. In 1938 the seed was produced about 3 weeks earlier. The plot was harvested with a combine August 11, 1938, and yielded 780 pounds of seed—378 pounds per acre. Purity tests for the seed harvested in both years are given in table 2.

The spikes composed of 6 to 8 spikelets are not broken up in threshing. This cluster of spikelets is of sufficient compactness to permit drilling through an ordinary grain drill. While the seed is somewhat bulky in this form, weighing about 8 pounds per bushel, it is not so light and feathery as to prevent satisfactory seeding. The rate should be about 20 pounds of seed per acre when the purity is 20 percent. A proportional increase or decrease in rate per acre should be made when the seed has a lower or higher purity test. It responds best to spring planting, in late March or early April, and should be covered to a depth of one-half inch. A firm seedbed, as prepared for alfalfa or other grasses, is desired.

Side-oats grama may be planted alone in central Kansas, but is ordinarily better suited to mixtures. A mixture of side-oats grama, blue grama, and buffalo grass is adapted to western Kansas. Droughty upland soil of eastern Kansas should be seeded with a mixture containing a high percentage of side-oats grama. A good mixture for average conditions in eastern Kansas is as follows: Big bluestem, 45 percent; little bluestem, 25 percent; side-oats grama, 25 percent; and switchgrass 5 percent.

RIVER BANK PROTECTION

By GEORGE A. HERION [1]

TO KEEP the farm land out of the river and the river out of the farm land is the immediate objective of all treatment involving bank protection on the upper Gila River. For the past 40 years many types of treatment have been planned and tried out, with varying degrees of success or failure, to control the meandering, fluctuating charge of this stream. The underlying factors contributing to failure were the absence of generally uniform methods, and the lack of sustained, concerted effort on the part of the landowners.

Prior to 1933 the farmers and ranchers in the Cliff, Gila, Duncan, Virden, and Safford valleys waged an unsuccessful war against the ravages of the rampant Gila. For the most part they worked independently, with little or no aid from a public or governmental agency. And then with the advent of the Soil Erosion Service of the Department of Interior, now the Soil Conservation Service of the Department of Agriculture, an agency was established which was to take an active part and interest in the problem. This agency supplied the necessary sustained and concerted drive which was needed. Cooperating with interested landowners, the Service tackled the problem immediately.

FROM THE START it was known that complete and absolute control could not be accomplished within reasonable cost limitations. In those early days it was believed also that steel and concrete were the only effective materials which would successfully combat and remain to combat the river. Later, revegetation of the channel banks was admitted into the picture. Revegetation, with a minimum of structural, mechanical protection, is the generally accepted solution today.

Observational evaluations of previous work and results were made, and these led to the elimination of widespread channel clearing, of river straightening by the construction of long pilot channels and of the widespread use of rail and rock revetments. Lengthy, heavily constructed rock jetties, earthen dikes, and driven pile and rock-filled piers were also discarded. The evolution from heavy, bulky construction to a

[1] Assistant forester, Soil Conservation Service, Santa Fe, N. Mex.

more streamlined and lighter type of structure brought lowered construction costs and, at the same time, more effective protection.

Structural protection is designed specifically to give immediate, short-time support to both the stream bank and to plantings. In addition to protection of plantings, many structures are designed to facilitate and ensure the future of the revegetation phase by preparing the planting site through silt deposition. Often mechanical protection is unnecessary to the establishment of plantings; but in other instances plantings cannot be undertaken without it.

THREE MAJOR TYPES of structural protection are now used on the Gila. The rail tetrahedron type is used most frequently and under a greater variety of conditions than either of the other two. For this type of treatment, costs range from $1.50 to $2.25 per lineal foot of bank protected. Specifications call for 50- to 70-pound railroad rail, with members 7½ or 10 feet in length. Tetrahedrons are placed in a continuous line between the stream and cut bank, so that stresses developed by stream flow against the line may be properly and evenly distributed along the line.

On curved cut banks, where this type is generally used, the line is placed in the form of a catenary, to distribute the force more uniformly. Two 1-inch steel cables run the entire length of the tetrahedron line, with one of the cables running through the apex of and clamped to each tetrahedron, and the other running parallel to the base of the line and likewise clamped to each structure. The upstream and downstream ends of each cable are securely and independently tied to substantially anchored deadmen. Such deadmen are usually set well back on the bank. Where the tetrahedron strings comprise a length greater than 250 feet, additional line anchors are needed. These should consist of three 15-foot, 50-pound rails driven into the streambed with 1 foot projecting above the surface, and with one rail at each of the three base vertices of the anchor tetrahedron securely fastened to the tetrahedron with clamp and cable. The line anchors are spaced at intervals of 125 to 250 feet, depending on the curvature of the line, and at critical locations with respect to stream flow.

TREE AND CABLE deflectors are placed at the line anchors extending from the tetrahedron line to the bank. This "groin" or deflector consists of overlapping trees and cable clamped to the tetrahedron and anchored to a rail driven into the bank. Deflectors of this type serve a twofold purpose. They cause deposition of silt between the line of tetrahedrons and the bank by decreasing the velocity of water flowing through and behind the tetrahedrons, and they function as a jetty which forces the water back to the channel.

Tetrahedrons are used on the most critical locations, often where the channel flow is directed at the cut bank and the banks have an overhang or sheer wall of 5 to 20 feet above the level of the channel bottom. They are well adapted to locations where quicksand makes a pile-driven structure impossible. In "quicky" or on soft-bottom, brush mats have been used to prevent sinking of the structure and misalinement of the entire string.

The driver rail and tree type of protection is used extensively on less critical areas where severity and degree of cut bank and the flow action of the river are favorable for lighter, less costly type of treatment. Cost per lineal foot of bank protected with this type of structure varies from $0.90 to $1.50. This bank protection consists of 20-foot, 50-pound rails driven down about 15 feet, with 5 feet projecting above the surface and set at 16-foot intervals along a line parallel to the cut bank in a position similar to that described for tetrahedrons. A single, 1-inch cable runs the entire length, and is attached to each rail by means of cable clamps; the cable ends are anchored to deadmen. A double line of overlapping trees is placed on the inside of and parallel to the line of rails. The lines are secured to each other and to the driven rail by means of short cable and clamps, in such a fashion as to permit the trees to rise and fall vertically without moving the rails. At intervals of 125 to 250 feet, log and cable groins or deflectors, similar to those used with tetrahedrons, are placed at a 30° angle with the direction of stream flow.

TREE AND CABLE revetment constitutes the other means of structural bank protection now employed quite generally on low-cut banks, or on straight sections of the river where the cutting action is not so intense or severe. This type of protection is definitely limited to the less critical areas where large trees are plentiful. Entire trees are placed about 6 to 8 feet apart, depending upon crown spread, along the bank with the butts on top of the bank and the branches extending into the water. The trees are placed at an angle of 30° downstream. Two lines of 1-inch cable are run the full length of the protected bank and are anchored on both ends to deadmen; the

Vertical planting method employed behind tetrahedron string. Planted March 1938; photograph made May 1938. Debris on face of tetrahedron lodged by floods. Recorded silt deposition behind line 3 feet.

trees are secured to the main cable by small ½-inch cable and 1-inch clamps. Where the supply of tree-size willows is plentiful, the use of this species for this type of mechanical protection has distinct advantages in that new sprouts originate from the branches when silt has been deposited on them.

It has been found advisable to defer planting behind mechanical protection until silt accumulations and deposits have been built up between the outer edge of the protection and the cut banks. In many instances it has been necessary to wait a full year before planting. Floods are seasonal, usually occurring in the winter and early spring. As the planting season is limited to a 3-month period—January, February, and March—the planting program behind such structures is limited to mechanical work completed during the preceding year. Where plantings are made as the only means of bank protection, it is unnecessary to wait for silt accumulations, as these plantings are made only on the cut bank.

TREE AND SHRUB FORMS of willow have proved to be the most effective plants for bank protection and stream channel stabilization. Due to the various and individual growth characteristics of the several species, selection of a particular one is based upon the job requirements of the problem present.

A tree willow, *Salix gooddingii*, is used on locations where the vegetation must furnish future mechanical protection in addition to the protection offered to the soil by the fibrous root system. The small, bush-type willow (several species, including *Salix exigua* and *Salix irrorata*) is used on the less critical sections of low-cut banks where mechanical obstruction to the flood waters is not desired, and where water must pass over them rapidly with a minimum of debris accumulation.

In bank protection planting, cuttings are preferred to nursery-grown or native rooted stock, as procurement, handling and planting costs are considerably lower. In addiiton, cuttings have two decided utility advantages in that they will afford some immediate partial mechanical protection and resistance to flood action, and they may be planted on more adverse sites and under conditions unfavorable for rooted plants. Comparative results as to the effectiveness and survival of either indicate no appreciable difference.

Cuttings are procured locally from native stock adjacent to the planting sites. Two classes of cuttings are made—the large, post-size class ranging from 4 to 16 feet in length and 1 to 9 inches in diameter; and the smaller size slip cuttings of 1 to 3 feet in length and one-half to 1½ inches in diameter.

THERE ARE THREE generally accepted planting methods employed; the vertical, horizontal, and the angular or stream-bank. Of the three, the vertical method is best adapted to a greater range of site variables and, therefore, is most frequently used. Under high-cut banks the vertical method is used entirely, as the cuttings planted in this manner are able to withstand bank sloughing. Large willow posts have been planted to depths of 16 feet, although this is an exception to the general rule which is from 4 to 8 feet in depth. Lack of moisture or excessive amounts, and poorly aerated soils, limit the use of vertical plantings. Cuttings planted in this manner must be inserted to live water, or to depths where the soil will remain permanently moist.

The requirements of the individual job establish the limits to which cuttings are permitted to extend above the ground. Where additional silting is to be expected, as in cases where plantings are made on silt beds deposited behind tetrahedrons, the posts are set to heights which allow for or will compensate for expected future depositions. In other instances where silting has reached the expected maximum, cuttings are set deep with a projection of 1 foot or less above the surface. The use of high cuttings (over 4 feet in height) has been generally discontinued, as they are wasteful of material and costly to cut, handle, and plant. To avoid livestock browsing, they have been planted to extend 8 feet above the surface. Fence construction, where possible, more than offsets the additional costs involved in handling poles of this size.

HORIZONTAL PLANTINGS are made on poorly aerated soils where moisture is close to the surface. This method of planting is limited to those wet, boggy areas that are formed between the line of mechanical protection and the cut bank. Cuttings are laid in shallow trenches 2 or 3 inches deep, and all but the upper side of the wood is covered with earth. Quite often it has been found necessary to anchor or tie them together to prevent them from washing away.

Where the site is favorable, horizontal plantings are usually made in jetty form extending from the cut bank to the outer edge of the protection, and in lines paralleling the mechanical structure. Sprouting takes place along the entire length of the material planted, and after two growing seasons becomes sufficiently established to grow independently of the parent stock. Although limited by site requirements, this method has been utilized with success where other methods have failed. Its low cost favors more general usage.

On less critical straightaway sections of the river that do not require mechanical protection, vegetative covering is quickly and easily established by the angular or stream-bank method of planting. It is often necessary to give the banks a 1:1 slope; the cuttings are laid in shallow trenches extending up the bank, with butts imbedded in muck or sand of the stream to a depth of 2 feet or more. The cuttings are partially covered with soil; this permits that the upper surface be alternatingly exposed and lightly covered. Where necessary, the cuttings have been anchored with No. 9 wire tied to driven stakes, or quite often tied to vertical cuttings planted at the toe of the slope. Plantings are spaced at intervals of 4 feet and effect a riprap appearance along the treated area. This type of planting forms a solid vegetative mat from the edge of the river to the top of the bank.

Bank protection and channel-control measures will not in themselves effect permanent protection for the adjacent farm lands unless they are constantly maintained and renewed. The ephemeral nature and character of the Gila River, the cutting and filling action, and the fluctuating flow all tend to create unforeseen conditions and problems which can only be met as the particular situation arises. Prolonged drought on the watershed, heavy snows, unprecedented seasonal rains, and simultaneous flooding of its tributaries offer daily and seasonal problems which affect the entire course of the river and the irrigated valleys dependent upon it. Plans made today are of necessity changed tomorrow.

Realization must come that continuous farming in the upper Gila Valley, under conditions contrary to most natural laws and tendencies, is an extremely hazardous occupation, and permanent control of the river and protection of the land can only be accomplished by a continued and lasting struggle against the forces of nature.

Pasture Management for Dairy Stock

Planning pasture management for small dairy herds is a difficult problem in most areas and the final solution for many of them is yet to be determined. United States Department of Agriculture Technical Bulletin No. 660, The Hohenheim System in the Management of Permanent Pastures for Dairy Cattle, issued October 1938, reviews and reports on one system adapted to intensively farmed areas. It may not be the answer to all questions but it is a fine contribution and the contents should be read by everyone interested in permanent pasture management.

—*Liter E. Spence.*

A stand of blue grama, obtained by stocking the range to grazing capacity of the forage.

STOCKMAN'S RECORDS REFLECT PROPER LAND USE

By HERSHEL M. BELL [1]

AGRICULTURAL WORKERS can learn much from progressive stockmen who have recognized the advantages of proper land use. Information gathered from such sources can be extremely useful in planning operations and in encouraging a spread of conservation practices.

Last spring (1938) I had the privilege of inspecting a ranch in west Texas at the end of a 12-months grazing season, just before new growth started. There was an excellent stand of grass, with only a few invading weeds, and grass seed stalks could be seen in abundance. This year, in February, I again visited this ranch and, although the land had been grazed for 7 months, the pasture appeared almost untouched by livestock. When I interviewed the operator he told me that he had records of his operations, and these records he generously opened for review.

In the first place, he had changed his rate of stocking from 36 head per section (640 acres) to 24 head per section, beginning with 1935. He did this by adding 10.5 sections of land to his ranch, thus indirectly reducing the rate of stocking. The forage on the ranch is composed chiefly of blue grama, black grama, and curly mesquite grass. The following tabulations were compiled from his records:

	Before 1935	*After 1935*
Size of ranch .... acres	14, 080	20, 800
Rate of stocking .... head per section	36	24
Animal units grazed	792	792
Pasturage per animal unit, year long .... acres	18	27
Ratio of bulls to cows	1 : 25	1 : 25
Calf crop .... percent	0. 65	0. 93
Weight of calves at sale time .... pounds	350 to 375	425 to 450
Average yearly expenditure for cottonseed cake	$1, 050	$520

[1] Acting regional range examiner, Soil Conservation Service, Fort Worth, Tex.

THE RANCH LAND is valued at $75,000; buildings at $7,500; livestock at $34,000. Operating expenses have remained approximately the same, but income has increased steadily since the change in rate of stocking.

Year	Gross income	Net income
1930		$5,000
1931		1,900
1932		769
1933	$5,494.75	1,500
1934	12,159.00	[1] —4,000
1935	11,647.68	2,800
1936	12,721.71	3,700
1937	17,011.52	5,000
1938	20,420.00	[2] 6,500

[1] Cattle sold under Government drought-relief agreement.
[2] Estimate.

THIS IMMEDIATE financial gain, resulting from range conservation practices, is fully recognized, but the more enduring result from such practices is in the protection and perpetuation of the rancher's investment in the land. On this ranch, accelerated erosion has been reduced if not stopped entirely. By diverting water out of drainages which were forming gullies, and spreading it over broad, flat swales he has made native haylands of from 400 to 600 acres which were formerly only fair to good grazing lands. More than half this area could be cut for hay as a reserve feed supply. This ranch unit is only one of many examples, both in practice and research, of the soundness and practicability of the principles of range conservation.

In the conservation of our grazing lands it is particularly important that the utilization of increased forage, produced as a result of conservation practices, be predicated first upon the effect it has on reduction of soil and water losses. If immediate increases in quality and quantity of forage are evaluated in terms of forage alone the beneficial effects will be short-lived and little or no change will be noted in erosion and water waste.

The Soil Conservation Service has stressed the need for range conservation. The policies under which it operates emphasize consideration of the entire farm or ranch unit in the plan; not only must the soil and water be conserved, but a balanced, practical and economically sound farm or ranch business must be established. In such a program it is believed that a fundamental principle which places priority on the reduction of soil and water losses and less importance on an immediate increase in forage, permits the accomplishment of both, but assures greater stability of the latter.

REFERENCE LIST COMPLETED FROM INSIDE BACK COVER

Soil Conservation in an Improved Agriculture. Bulletin 362. Agricultural Experiment Station, University of Missouri, Columbia, Mo. March 1936.

Soil Erosion—Causes and Methods of Control. Special Bulletin 160. Minnesota Agricultural Experiment Station. August 1933.

Soil Erosion—A Local and National Problem. Research Bulletin 99. Agricultural Experiment Station, Madison, Wisc., cooperating with the Lake States Forest Experiment Station, Forest Service, U. S. Department of Agriculture. August 1930. (Out of print.)

Southern Great Plains Region

Land Facts on the Southern Plains. Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 334. 1939. 30¢.[1]

Problem-Area Groups of Land in the Southern Great Plains. Soil Conservation Service. Feb. 1939. 30¢.[1]

Soil Conservation Reconnaissance Survey of Southern Great Plains Wind-Erosion Area. Jan. 1937. Soil Conservation Service, U. S. Department of Agriculture Technical Bulletin 556. 25¢.[1]

Soil Blowing and Its Control in Colorado. Colorado Agricultural Experiment Station, Fort Collins, Colo. Bulletin 419. Jan. 1936.

Soil Erosion by Wind. Kansas State Board of Agriculture. Vol. LVI. No. 224–A. Report of the Kansas State Board of Agriculture. Dec. 1937.

Northern Great Plains Region

Soil and Water Conservation in the Northern Great Plains. Soil Conservation Service, U. S. Department of Agriculture. 1937.

Conservation and Use of Soil Moisture at Mandan, North Dakota. Bureau of Plant Industry, U. S. Department of Agriculture Technical Bulletin 617. June 1938.

Conservation of Montana's Irrigated Lands. Bulletin 350. Montana Agricultural Experiment Station in cooperation with Bureau of Agricultural Economics and Agricultural Adjustment Administration, U. S. Department of Agriculture. Dec. 1937.

Erosion and Related Land Use Conditions on the Froid Demonstration Project, Montana. Soil Conservation Service. U. S. Department of Agriculture. Nov. 1938. 15¢.[1]

Erosion and Related Land Use Conditions on the Minot Area, North Dakota. Soil Conservation Service. U. S. Department of Agriculture. Nov. 1938. 65¢.[1]

Soil and Moisture Conservation in Nebraska. Extension Circular 118. Extension Service, University of Nebraska. June 1938.

Southwest Region

Vine-Mesquite for Erosion Control on Southwestern Ranges. Southwestern Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture. Leaflet 114. Feb. 1936.

Range Conditions in the Uinta Basin, Utah. Bulletin 283. Utah Agricultural Experiment Station in cooperation with Forest Service and Soil Conservation Service, U. S. Department of Agriculture and Division of Grazing and Bureau of Indian Affairs, U. S. Department of Interior. Oct. 1938.

Soil and Rainfall Conservation in New Mexico. Bulletin 238. New Mexico Agricultural Experiment Station. April 1936.

Pacific Northwest Region

Soil and Water Conservation in the Pacific Northwest. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1773. July 1937.

Erosive Effects of Heavy Summer Rains in Southeastern Washington. Washington Agricultural Experiment Station Bulletin 271. July 1932.

Soil Fertility in Relation to Productive Land Value. Oregon Agricultural Experiment Station Circular 113. Oct. 1935.

Pacific Southwest Region

Soil Erosion in California: Its Prevention and Control. California Agricultural Experiment Station Bulletin 538. August 1932. (Out of print.)

[1] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

CONTOUR CULTIVATION STUDIES WITH THE RAIN SIMULATOR

By H. L. BORST and RUSSELL WOODBURN [1]

Four inches of rain per hour on contoured corn.

WHAT HAPPENS when contour cultivation furrows fill and overflow during a heavy rain? The virtue of contour cultivation as a soil conserving measure is generally well appreciated. Tests of the practice at the various Soil Conservation experiment stations and by workers elsewhere have shown its value. Although the value of the practice for average rainfall is well established, there is a question as to what actually happens when the ridges are overtopped and cut through by run-off from intense rainfall. In such cases, is the soil loss less or, perhaps, more than it would have been from a field cultivated with slope? The opinion is current that in heavy storms the accumulated water in the furrows, augmented by rainfall, surges through breaks in the ridges and causes greatly accelerated erosion.

During the progress of experiments with an artificial rainfall apparatus at the Zanesville Soil Conservation Experiment Station, a somewhat preliminary study was made to evaluate the effect of contour cultivation on soil and water losses and, possibly, to answer the questions just mentioned.

Three Plots

THREE PLOTS were installed in the spring of 1938 on a 15-percent slope of Muskingum silt loam soil. The plots were 72.6 feet long by 6 feet wide, or one one-hundredth acre in area, and were planted to corn. The rows of corn on one plot were planted up and down the slope. On the other two plots, the rows were on the contour. The corn plants were about 16 inches apart in the row. Soybeans were planted between the corn plants on one of the contoured plots. The plots were cultivated by hand during the summer and in so doing, the contoured rows were ridged to a height of 3½ to 4 inches above the slope line or a vertical height of about 2½ inches. Rain simulator tests were made on the plots late in the season. Although at this time the corn was still green, the soybeans had ripened and some of their smaller roots had decayed. The contour ridges had become quite firm and were reinforced to some extent by root growth.

Two series of runs were made on the noncontoured plot; one series after it was cultivated level, and then a series after it had been furrowed up and down the hill. The tops of the ridges of the contoured plots were carefully leveled before the tests were made in order to make both plots comparable. These plots were cultivated crosswise before the tests and an earth seal was made between the ends of the ridges and the plot side metal.

As the plots were 6 feet wide, the condition tested was practically similar to that in an ordinary contoured field with dams placed in the furrows every 6 feet. Since the ridges were truly on the contour, well compacted and free from weak points, the experiment

[1] The authors are project supervisor and associate agricultural engineer, respectively, at the Soil Conservation Service Experiment Station, Zanesville, Ohio. The article is a contribution from the Division of Research of the Service and the Ohio Agricultural Experiment Station, Ohio State University.

(plainly "loaded" in favor of contour cultivation) measured ideal contour cultivation or "contour cultivation at its best," rather than a field condition wherein it is practically impossible, with ordinary farm machinery, to lay out contour rows that are absolutely level.

Three "Rains"

AFTER THE RAINFALL APPARATUS was assembled over a plot, three different "rains" were applied. The first two were each 1 inch of rainfall at 4 inches per hour, and the third, 2.70 inches at 8.75 inches per hour. In each case, the run-off from the plot was conducted to a tank for measurement and sampling. There was little delay between runs, and therefore it should be understood that the plots received 4.70 inches almost as one rain. Four inches per hour for 15 minutes represents a 6-year frequency rain for the station, and 8.75 inches per hour for 18½ minutes is in excess of the so-called 100-year frequency. There is, therefore, little question as to the unusual and highly destructive rainfall applied to the plots.

The soil and water losses recorded are shown in table 1.

Water Losses

IT WAS of considerable interest during the runs to note the large amount of water which the soil of the contoured plots was literally forced to take in—this because of the ponding above the ridges; it was particularly noticeable during the first runs. Run-off started from the noncontoured plot within 3 minutes after "rain" was applied, and the total water loss was nearly 50 percent. On the contoured plot with corn only, about three-fourths of an inch of "rain" was applied before run-off started, and the inch of rainfall produced only 8 percent run-off. The first inch of rain on the contoured corn and soybean plot produced no run-off. All of this rain was stored in the furrows and the apparent effective infiltration rate was therefore equal to the rain intensity. Run-off was also significantly reduced from both of the contoured plots during the two subsequent runs.

Soil Losses

THE SOIL LOSS was very low from all contoured plot runs. The losses from the contoured plots for the 8.75-inch per hour rainfall amounted to only about one-ninth of that from the corn cultivated with the slope.

The reason for the low soil losses from contoured corn (in spite of considerable run-off from the 8.75-inches per hour intensity) was apparent during and after the run. Pools of nearly quiescent water formed in the furrow above each ridge. These pools were, in effect, sedimentation basins. The velocity of the run-off water entering these pools was so much reduced that much of the suspended soil in the run-off dropped out. As the ridges were cut through by the overflowing water, the depth of these small detention basins was gradually lowered until only a small depth of water was left in the furrow. Even after the furrow ceased to act as a detention basin, a comparatively flat section in the plot gradient remained. The velocity of run-off continued to be low across this flat reach, and deposition continued. The efficiency of this sedimentation system was evidenced by terraces or deltas of considerable size in the depression below each ridge. It is particularly significant that deposition continued after the ridges were cut through, and there was little tendency toward accelerated erosion from the water stored in the furrows.

(Continued on p. 16)

Table 1.—*Comparison of soil and water losses from noncontoured and contoured corn plots*

Run No.	Rainfall			Plot 1—Noncontoured corn			Plot 2—Contoured corn			Plot 3—Contoured corn, soybeans		
	Intensity	Duration	Amount	Run-off	Infiltration	Soil loss	Run-off	Infiltration	Soil loss	Run-off	Infiltration	Soil loss
	Inches per hour	*Minutes*	*Inches*	*Percent*	*Inches*	*Tons per acre*	*Percent*	*Inches*	*Tons per acre*	*Percent*	*Inches*	*Tons per acre*
PLOT 1—CULTIVATED FLAT												
1	4.00	15	1.00	52.1	0.48	5.20	....	....	....	....	....	....
2	4.00	15	1.00	88.5	.11	8.46	....	....	....	....	....	....
PLOT 1—CULTIVATED WITH FURROWS UP AND DOWN SLOPE												
3	4.00	15	1.00	47.8	0.52	5.60	8.0	0.92	0.36	0	1.00	0
4	4.00	15	1.00	88.9	.11	7.45	48.7	.51	.48	46.4	.54	1.00
5	8.75	18.5	2.70	95.0	.14	26.4	78.4	.59	2.85	68.0	.86	3.05

The Growth of Liming

By Paul Bissell [1]

FOR THE past several years, the Soil Conservation Service and the Civilian Conservation Corps have worked together in demonstrating to farmers, and to the public in general, methods and practices for relieving or entirely eliminating land ills through the intelligent use of means either at hand or readily available. The many accomplishments of this type of cooperative work can be seen on every side throughout the country. Often little more was needed than to emphasize an existing condition and to point out through demonstration an easily adaptable remedy that had been at least partially overlooked. Liming, as a soil-conditioning practice for erosion control and with its attendant increased crop yields, is an example of such a cooperative demonstration by the Soil Conservation Service, the C. C. C., and the farmer.

For many generations farmers have added lime to the soil, knowing that in general their crops would be improved. The practice, however, was confined primarily to the "sweetening" of sour or acid soils. To many farmers the term "liming" suggests only those neutralizing effects obtained when the alkaline action of lime comes in contact with the acids in the soils. Other beneficial effects of liming often are not considered, and this is unfortunate.

Although it is true that the neutralizing or sweetening of acid soils is one great virtue of liming, this is not the only benefit or perhaps the most important one to be obtained from the use of lime. Were the other benefits fully appreciated by all farmers there is little question but that liming would be an even more universal practice than it is.

Soil acidity is the result of either of two major conditions. In soils comparatively free of organic matter, it is caused by the presence of compounds of an acid nature derived from silicates which constituted a large part of the rock from which these soils were formed. In other soils, it is caused by the decay of organic matter which is present to some extent in all soils. In either case, under natural conditions certain processes ordinarily tend to prevent these acids from accumulating to any injurious extent. When they do accumulate to excess, however, acid or sour soil is the result.

Acid soils do not produce maximum yields for most crops, and liming is a specific remedy for this condition. Extremely acid soils are not as prevalent as is often supposed and, furthermore, it is absolutely essential that organic decomposition be encouraged in soils even at the risk of increasing acidity, for it is largely through this decomposition process that crops can grow. In fact, by the use of fertilizer, manure and cover crops, farmers must constantly add organic matter to the soil, solely for the benefits to the soil from decomposition of these materials.

Enrollees at work clearing a field of an outcropping of limestone. The limestone was burned and used for liming the field.

And so it is that the farmer faces a greatly complicated problem. Organic decomposition is essential for the growing of crops, and he must encourage it to the extent of supplying material for it if he is to expect increased crop yield; and yet he knows that this very process will produce acids which, if they are present in excess, will tend to cut down the increase he is striving for. Happily for the farmer, liming offers him a solution. Lime added to soils in such instances acts in a dual role. It stimulates the much desired decomposition process and thus creates a soil condition most favorable to growing crops and, at the same time, by its acid-neutralizing action it prevents the accumulation of acid in excess. Now, since only a small proportion of soils are really sour (and only "sour" soils are referred to when the value of "sweetening" quality of liming is discussed), it is obvious that liming, as the term is generally understood, benefits only a minor portion of the soils of the country. On the other hand, the stimulation of organic decay is beneficial and really essential to both sweet and sour soils, all soils; and since liming offers this stimulation, it can

[1] C. C. C. information, Soil Conservation Service, Washington, D. C.

be concluded that this is the more important of the two benefits.

In some soils, liming seems to offer the further advantage of furnishing calcium directly to the plant. All plants need calcium to build up their tissues. All soils contain some calcium, and in the past it has been generally assumed that all soils contained enough of this element for plant growth. But we know that in some soils this calcium is in a form only slightly soluble and is not readily available to plant life. It has been proved, by experiment, that the addition of lime to such soils increases crop yields. Lime is calcium in oxide or carbonate form, and it is more soil soluble than the calcium silicates which already exist in the soils mentioned. It appears, therefore, either that such soils are deficient in soluble calcium and that this need is supplied directly to the plant by the lime, or that the lime causes some other reaction, beneficial to plant life, in the soil itself. Probably both are true to some extent. Certainly, the lime (calcium) is free and available to the plant; and it is generally accepted that lime makes soluble and available for plant food other minerals, such as phosphorus and potash, contained in the soil.

Lime also affects the physical characteristics of some soils. In heavy soils, which contain large proportions of clay or silt, the fine soil particles often become associated so closely that free circulation of air and water is prevented, and this is unfavorable to plant growth. If these fine particles can be made to gather in large groups, however, each group behaving as one large particle, the soil particles are then said to have "flocculated," and the soil has a crumb structure. Farmers know that a crumbly condition in this type of soil is most desirable. Liming has been found to assist materially the flocculation of heavy soils.

Though these many benefits to the soil through liming are all known to farmers, nevertheless the need for lime in the soils never has been adequately met—and this in spite of the fact that lime in various natural forms such as limestone, marl, marble, coral and oyster shells is readily available to most farmers. Indeed, it was estimated in 1933 that the annual lime requirement of American farms was 24 times the amount sold by commercial concerns in that year—the year in which the Soil Conservation Service was founded.

Since its beginning the Service has recognized the need for more lime in the soil, and has consistently advocated liming as an approved practice. The result has been an increased demand for agricultural lime from commercial companies. There has also been a heartening response from farmers themselves, in quarrying local limestone deposits and liming their fields with the quarried rock, after it was either crushed or burned.

Perhaps in no section has this advocated practice of liming been more generally accepted than in West Virginia. The farmers in this State needed only the help and direction of technical experts to encourage them in using this gift of nature in the form of limestone outcroppings.

These outcroppings were, of course, not always on the surface; in many instances they are visible now only as a result of erosion caused by forest destruction and overgrazing. Since a land underlain by soluble limestone offers difficult problems in soil erosion control, it might easily be argued that this limestone is not wholly a blessing. Nevertheless, these outcroppings will furnish lime in abundance, and lime is essential in revegetating many partially eroded areas existing today.

With this practical viewpoint regarding the liming problem the Soil Conservation Service extended advice and aid to West Virginia farmers who had signed cooperative agreements with the Government. Many of the farmers had overgrazed pasture lands or fields which, under the agreements, were to be retired to permanent pasture. The pastures needed to be revegetated with erosion-resistant grasses. Outcroppings of limestone were tested for the richness of their calcium content. Then, C. C. C. enrollees, under the direction of Soil Conservation Service technicians, were put to work quarrying the rock. Sometimes these outcroppings were large and, when centrally located, they furnished rock for several cooperators. Sometimes the work was done on the individual farm. Where rock crushers were available, or where through other Federal, State, or county agencies they could be obtained, the rock was crushed and used in pulverized form. In some sections of the State, however, particularly where fuel was available at low cost, burning rather than pulverizing was the procedure more generally used.

Though the burning of limestone to obtain rock lime has been practiced for generations, when the Service began its program in West Virginia there was a dearth of available men experienced in this work, just as there was little technical data on kiln or stack construction. Faced with the necessities of the situation, the regional and project engineers, the technical staffs at the camps, and the C. C. C. enrollees themselves cooperated in evolving plans for a standard kiln and stack for use throughout this region.

Blueprints of the completed plans were then made available to the farmers throughout the entire State.

As the work progressed, slight improvements were made from time to time in both design and methods. The suggestions came not only from the engineers and superintendents but in some instances from the enrollees themselves.

Often the limestone was burned at a central location, so that it was possible to furnish rock lime to many cooperators from the one kiln. In such an instance, a special detail of C. C. C. enrollees was assigned to this kiln, which was kept burning continuously for many months. In other areas the cooperators were encouraged to build stacks, with the help of C. C. C. labor, so that the limestone could be burned for farm use. Whether the process was pulverizing or burning, however, virtually all the liming materials made available by the Soil Conservation Service were obtained through the C. C. C. enrollee labor. These materials could then be used only on eroded lands, or lands subject to erosion, for the establishment or improvement of erosion-resisting vegetation upon such lands. The lands must be within project or work areas, and the owners of such lands must have signed cooperative agreements with the Soil Conservation Service.

Primary consideration was given to lands devoted to permanent pasture, hay, and orchards. Secondary consideration was given the croplands where legume-grass mixtures were incorporated for two or more successive years in rotation. Furthermore, while encouraging farmers to use lime, the amount of liming materials furnished by the Government was kept at a minimum, and in no case was it allowed to exceed one-third of the aggregate amount called for in the cooperative agreement. It was not the policy of the Government to make delivery of liming materials to the farmers; and also, care was exercised, in the processing of lime, to grind or burn only an amount sufficient to meet the definite terms of the cooperative agreement and to set up demonstrations to show to farmers the benefits of a liming program. After observing the demonstration the farmer could secure sufficient lime, either by processing or purchase, to treat the remaining portions of his farm.

While the Service furnished liming materials only to farms within project or work areas, nevertheless the demonstrations of liming on cooperators' farms aroused the interest of many farmers outside these areas, and there was a demand for blueprints of the standard stack and kiln. More than 500 of these were furnished from one project, in response to personal requests by land owners, and the result is that many farmers are obtaining rock lime by burning limestone from their own outcroppings in their own stacks or kilns.

Soil Conservation Service cooperator liming pasture. Here the spreader is being filled.

In the camp and project areas, more than 11,000 tons of lime have been burned by the C. C. C. enrollees, and 64,000 tons have been crushed. These figures are encouraging; yet the actual tonnage of lime used in the fields is of secondary importance as compared with the indisputable fact that, by cooperative demonstration, the Soil Conservation Service and the C. C. C. have aroused the farmer to the full benefits to be obtained by liming and have pointed out the ways and means for gaining these desired benefits. With this impetus there seems every reason to expect that the practice of liming will increase steadily, with benefits to the soil, to farmers, and to the lime industries throughout the Nation.

RAIN SIMULATOR

(Continued from p. 13)

Under field conditions, the picture would be quite different from the ideal situation which obtained during these tests. The ridges would be low during the early part of the season and would be loose and easily damaged when first thrown up by cultivation. Rows would frequently be off-contour, and lateral flow would result. Concentration of run-off would take place at depressions and weak spots. Although the experimental conditions were not the same as true field conditions, nevertheless a valuable lesson was presented.

The effect of lowering the velocity of run-off, even momentarily, was shown to be very important in reducing both soil and water losses. The nearly quiet or slowly moving water above the ridge was extremely effective in causing the run-off to drop its load. The necessity of adhering to true contour as nearly as possible is emphasized, as the true contour tends to spread run-off over a long stretch of ridge and minimizes concentration. Since a certain amount of contour divergence may be inevitable in any field, the need is indicated for a device which will place dams in the furrows at short intervals.

(Continued on p. 20)

Revegetative and Gully-Control Experiments in the Red Plains Region

By H. M. Elwell, J. W. Slosser, and Harley A. Daniel

ACCORDING to recent information (6), the abandonment of cultivated land has gradually increased in this region during recent years. Reports (1) also show that over 1,359,000 acres of Oklahoma soil have been retired from crop production. Because of the rapid destruction of this great agricultural country, the State Experiment Station obtained an area of submarginal land in 1932 on which, in cooperation with the Soil Conservation Experiment Station, several valuable studies were introduced.

Since Vernon soil is a predominating series of the Red Plains region and erodes easily (3, 5), revegetative and gully control studies were investigated on a typical area. The various experiments occupied about 70 acres of land which had been abandoned for crop production. There were many gullies ranging from 5 to 12 feet deep. An erosion survey shows that about 12 inches of the surface soil was removed during a period of about 37 years of continuous cultivation.

Under virgin conditions, this soil was underlain by sand, stone, and shale at a depth ranging from 2 to 4 feet, with occasional surface outcrops. The native soil was rather high in organic matter and the rate of infiltration fairly high. This dark surface layer varied from 6 to 18 inches in depth and was very erodible under cultivation. Once this surface soil is removed by erosion, the remaining subsoil has very little fertility, a low infiltration rate, and a restricted reservoir for the storage of water. Consequently, run-off and soil losses are extremely heavy. Conclusive evidence of this may be obtained from a study of the data recorded from the controlled plots at the Guthrie Station (2 and 5). The percentage of run-off from the artificially eroded Vernon soil was about double, and the soil loss was 1.5 times greater than that of an adjacent cultivated surface area of the same size. Both areas are farmed to continuous cotton, with rows up and down the slope.

The land when placed under observation in 1932 had a sparse vegetative growth of annual and perennial grass. The degree of erosion and one of the gullies may be seen in photograph No. 1. An attempt was made to divert the run-off from the original channels by construction of small cheap contour ridges between and above the source of the gullies. These small terraces were built with one or two rounds, with a horse-drawn long-wing plow. Wherever possible, these structures were drained into areas of grassland. The method used was conducted very economically, so that the cost of construction did not exceed the value of the land.

Gully control work was conducted principally with temporary structures made of native material. They were designed to catch soil on which vegetation could be established. Brush and pole dams of different types were built at various places, their life being an average of about 2 years or less. Burrowing animals and rodents have caused many failures because this type of structure is a natural harbor, although the usefulness of such dams may be increased if vegetation is established just above the site shortly after construction is completed. Usually, considerable soil is removed from the banks and floor of the channel in placing the material used for making dams. During this operation, if this soil is placed above the dam it provides a place where sods of native grasses, such as Indian, *Paspalum floridanum*, and little and big bluestem, may be set. The best results have been obtained when a small amount of soil, taken from the area where the sod was removed, was carefully placed around the vegetative plantings.

Other dams, such as Bermuda sod bags and small loose rock, were tried, but with little success. Attempts were made to establish trees and vines on the fills above these dams, but the eroded material that washed into them was very infertile and the shallow soil caused a high mortality rate of these plantings.

The most satisfactory results were obtained from legume plantings in gullies on eroded areas, especially biennial sweetclover which received applications of 100 pounds of lime and 50 pounds of superphosphate per acre. The second year's growth of sweetclover in a gully with such fertilizer treatments is shown in photograph No. 2. This seed was planted broadcast at a rate of 15 pounds per acre. Temporary check dams of stalk were prepared, and the sides of some of the gullies were plowed down to approximately 1:1 slope before the area was planted. *Lespedeza sericea*

NOTE.—The authors are assistant soil conservationist, associate agricultural engineer, and project supervisor, Soil Conservation Experiment Station, Guthrie, Okla. They wish to express their appreciation to Horace J. Harper for assisting with the sweetclover studies, to B. F. Kiltz for furnishing grass seed, and to H. G. Lewis and others for making the experiments possible.—Editor.

1. One of the gullies on the East Farm of the Soil Conservation Experiment Station at Guthrie, Okla., in 1932 before any experiments were started.

2. The second year's growth of sweetclover that received 100 pounds of lime and 50 pounds of superphosphate per acre. These plants are growing in the same gully as shown in figure 2, after the banks were cultivated to about 1:1 slope.

3. A good protective cover of native climax grass on Vernon soil that has been out of cultivation for about 25 years. This is a result of natural reseeding under favorable environmental conditions.

has made a good growth, without fertilization, in gullies and on eroded plots at several locations on the station. Experimental tests on eroded areas with little and big hopclover, yellow trefoil, southern and manganese bur clover, Korean lespedeza, vetch, and kudzu, were failures even when fertilizer and lime were applied.

Other fertilizer experiments with sweetclover were conducted on adjacent badly eroded Vernon fine sandy loam in 1935. The results obtained from three series, consisting of 5 plots each, on treated and untreated areas, are as follows:

Plot	Treatment	Pounds per acre of fertilizer [1]	Yield [2] of dry sweetclover per acre		
			A [3]	B [4]	C [3]
			Pounds	Pounds	Pounds
1 (check)	No treatment	....	665	105	670
2	Superphosphate	40	1,395	270	1,025
3	Rock phosphate	40	2,255	165	1,750
4	Superphosphate and limestone.	40 80	1,975	555	1,605
5	Rock phosphate and limestone.	40 80	2,240	590	2,060

[1] All applications of phosphate and limestone were made in the drill row at the time of planting, under the seed.
[2] Yields from second-year growth, planted at the rate of 2½ pounds of seed per acre in rows 3 feet apart.
[3] Planted in shallow listed furrows.
[4] Planted in smooth seedbed.

These data show that light applications of phosphate and lime increased the yield of sweetclover three to four times. Studies of similar treatments on other soils in Oklahoma were reported by Harper (4). In this report he states that "the application of fertilizer in the drill row with sweetclover seed indicates that the rock phosphate is more effective in increasing the yield of sweetclover than equal amounts of superphosphate applied under similar conditions." Although this area was seeded to native grasses following the experiment, the volunteer sweetclover produced

a nice growth last year. These results also indicate that badly eroded land may be made to produce enough forage for limited grazing, and increase the organic matter content of the soil. The latter seems to be necessary before seeding or sod plantings of the native climax grasses will produce much growth or cover.

Several studies have been made with seed plantings of the following grasses on well-prepared seedbeds: *Andropogon scoparius*, *Andropogon tener*, *Andropogon saccharoides*, *Andropogon furcatus*, *Bouteloua gracilis*, *Panicum obtusum*, *Panicum virgatum*, *Triodia flava*, *Sporobolus airoides*, *Sorghastrum nutans*, *Cynodon dactylon*, *Buchloë dactyloides*, *Paspalum dilatatum*, and *Agropyron smithii*. The *Bouteloua gracilis* and *Sporobolus airoides* made a fair ground cover the first year after seeding. All of the *Andropogons* made a very poor ground cover even after the third year of growth. These grasses, especially *Andropogon scoparius* and *furcatus*, seem to require a higher condition of fertility than the other two *Andropogons* and the *Bouteloua gracilis* or the *Sporobolus airoides*. Low available nitrogen and the poor physical condition of the eroded Vernon soil of the region appear to be two of the limiting factors in obtaining a profitable growth of the climax grasses.

The punishment that native anticlimax grasses will stand and their low nutrient requirements for survival may be observed in many localities. The erosion-resistant capacity of these grasses is an important factor in the process of establishing vegetative cover. Observations made at this stage of the revegetative process indicated that the roots and turf form small areas that are practically impervious to erosion. As the soil continues to weather and the vegetation to decompose, there is a tendency for a surface accumulation of residue and lichens. Through these slow-forming agencies, more favorable conditions are created for plant development. The addition of this organic matter offers an opportunity for better infiltration of moisture, and as a result, more seedings are started. This process of securing an erosion-resistant cover is slow, even under favorable environmental conditions.

According to the best information available, an area of adjacent land, pictured in photograph No. 3, has been out of cultivation about 25 years. No conservation methods were practiced, and there has been very little grazing. The erosion problems appear to be about solved on this particular site, and the vegetation ready for some utilization. Such information shows that a considerable period of years is required under natural plant succession, to change the nutrients and physical condition of Vernon soil so that it will support a protective cover of climax grasses.

Results obtained at this station indicate that the time required by nature for the establishment of such grasses may be reduced through the use of economic conservation practices and the introduction of legumes.

Summary

The State Experiment Station, realizing the importance of conserving soil, obtained an area of eroded, abandoned Vernon soil near Guthrie, Okla., in 1932. In cooperation with the Soil Conservation Service, about 70 acres of this land were immediately occupied by several revegetative and gully control experiments.

The gully control work was conducted principally with temporary structures made of native material. Brush and pole dams of different types were built at various places, the life of which has been an average of 2 years, or less. The usefulness of such dams may be increased if vegetation is established just above the site shortly after construction is completed. Other structures such as Bermuda grass sod bags and small loose rock, were tried out with little success. Attempts were made to establish trees and vines on the fills above the dams, but the eroded, infertile, shallow soil caused a high mortality rate of these plantings.

The most satisfactory results have been obtained from the setting of clumps of native grass, such as Indian, little and big bluestem, and *Paspalum floridanum*, and the seeding of perennial sweetclover and *Lespedeza sericea* in gullies after temporary check dams of stalk were prepared and the banks plowed down to approximately 1:1 slope. The best growth of sweetclover was obtained where the soil was fertilized with 100 pounds of lime and 50 pounds of superphosphate per acre.

Observations have shown that a considerable period of years is required under natural plant succession to change the nutrient and physical conditions of Vernon soil so that it will support an erosion-resistant cover of climax grasses.

Literature Cited

1. C. P. Blackwell: Research Leads to Farm Progress. Report of Oklahoma Agricultural Experiment Station, 1926–30, pages 13 to 18.
2. Harley A. Daniel, Harry M. Elwell, and Horace J. Harper: Nitrate Nitrogen Content of Rain and Run-off Water from Plots under Different Cropping Systems on Soil Classified as Vernon Fine Sandy Loam. Soil Science Society of America, vol. 3; 1939.

(Continued on p. 20)

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE NORTH AMERICAN ASSAULT ON THE CANADIAN FOREST. By A. R. M. Lower, W. A. Carrothers, and S. A. Saunders. Toronto, New Haven, and London. 1938.

As the work of our Service takes definite form throughout the United States and broadens in scope and idea, a study such as this, which treats the continent as a whole, assumes significance to the reader who likes to keep one step ahead of forestry trends as related to the conservation of natural resources. Certainly, it behooves us to know what has happened and is happening to the immense forest lands to the north of us and the role we, the great consumer Nation, have played and are playing in changing the widely varied tree map between the oceans—and the soil map with it. As for maps, read the book with the erosion map of the United States propped up in front of you; you will wish that it extended northward to include the Canadian regions of timber supply.

The extensive volume was compiled, to use the first author's own words, for . . . "the promotion of sympathetic cooperation in attacking our common North American problems and of understanding our common environment." It is, in reality, complementary to other volumes of a series on the relations of Canada and the United States.

Professor Lower's share of the book, the first 223 pages, is a geographical and historical study of lumbering in eastern Canada in relation to the American demand markets, and is presented from the standpoint of the regions involved in forest exploitation on the continent since those early days when white men began "lumbering" their way westward: First, the great forests of New York State, then into southern Ontario, through the Michigan, Wisconsin, and Minnesota hardwoods and conifers, northwestward to the banks of the Saskatchewan, and onward to California and British Columbia—the ever-growing army of lumbermen following the way of the trees to supply increasing demand. Here is found a most thorough and interesting analysis of continental river systems, early forest cutting and land changes and migrations, with the development of the canal and the railroad in a long-sustained attack on forest areas ranging over a territory as vast as that of Europe. The chapter on supply forests is especially illuminating in its delineation of range of white, red, and Banksian pine, the black, white, and red spruce, balsam fir, hemlock, the tamarack, and the white cedar. The white and red pines receive rather extensive treatment as to commercial importance, extent of present stands, environment, and effect of exploitation. Two chapters on woods operations, river driving, and sawmills give an outline history of the development of present-day lumbering operations.

The remainder of Professor Lower's portion of the volume presents an extensive study of lumbering for export in Canada, from early days of West Indies trade before the Revolutionary War when American forests were considered "inexhaustible." The reader is guided through periods of vicissitudes and change, into the era of the Reciprocity Treaty and the rise of American competition for Canadian raw materials, and then on to the present and the new trade agreement between the two countries. The old "forest buccaneer" days are gone forever from the eastern part of the United States where rapacious exploitation started more than two centuries ago. The Canadian Appalachian region, the Canadian Shield (Laurentian Plateau), and the northern (Canadian) Cordilleran area are shown to be the regions of continental forest supply today. Indirectly, Professor Lower's final chapter is a plea for careful thought and planning regarding the continental forest problem. With reforestation going forward in the United States, cannot the great Canadian stands still in existence be conserved as permanent supply?

The second author, Professor Carrothers, writes over a hundred pages on forest types, forest tenure, lumber trade and markets, and the shingle and pulp and paper industries of British Columbia. A great volume of data is included to show the far-flung extent of these related industries. It is a straight-forward statistical presentation, with no indication that sustained-yield methods are being used in the British Columbia forests.

S. A. Saunders, in the final 20 pages of the book, treats the forest industries of the Maritime Provinces—New Brunswick, Nova Scotia, and Prince Edward Island. And here there is an indication that conservation methods will be applied in the near future for the sake of the economic structure of the region.

The significant thing about this exhaustive economic and historical study is that it emphasizes a middle continental story, little realized, in which Canadian-American relations have had profound effect upon the exploitation of a great continental resource—the trees. We may study migration and exploitation in the United States "by way of the grass" without crossing the Canadian border; but when it comes to the forests, the story of their growth and extent, their death at the hands of man, and the economic implications of their rotting stumps goes back and forth and far to the north and far to the south of any political borderline.

The authors have included extensive bibliographies; a geographical-historical index; diagrams showing forest products in Canadian-American trade; and maps showing range of red and white pine, centers of lumber production of eastern Canada, forest reserves, and forest districts in British Columbia. In addition, an excellent inside-cover map, in color, shows the four great geographical regions of the continent, extending into the Arctic Zone, with the tree zones superimposed.

RAIN SIMULATOR

(Continued from p. 16)

Some question as to the agronomic feasibility of this type of cultivation may be raised. Flat cultivation has been in vogue for some time. Even in Ohio, however, water may be a limiting factor in crop production, and it would seem that the saving of water by contour cultivation would offset any possible bad effect of ridging so that increased yields would result. The acre yields of corn from the plots used in the test were 9 bushels on the noncontoured plot and 15 and 18 bushels on the contoured plots. There was an indication, at least, of increased yield from the contoured plots.

Cultivation ridges similar to those on the contoured plots are entirely feasible if the proper implement is used.

EXPERIMENTS IN RED PLAINS

(Continued from p. 19)

3. Henry M. Eakin: Silting of Reservoirs, U. S. Department of Agriculture Technical Bulletin 524, July 1936.
4. Horace J. Harper: Soil Fertility and Sweet Clover Production in Oklahoma. Oklahoma Agricultural Experiment Station Bulletin 206, 1932.
5. H. O. Hill, Harry M. Elwell, and J. W. Slosser: Soil and Water Conservation Investigations, Progress Report, 1930–35, Red Plains Soil Conservation Experiment Station, Guthrie, Oklahoma. SCS-ESR-3, July 1937.
6. Angus McDonald: Erosion and Its Control in Oklahoma Territory. U. S. Department of Agriculture Miscellaneous Publication 301, March 1938.

Erosion Control Picture Outlined In Printed Matter of Ten Regions

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field Offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

National

Protecting Investment Values in Land. Agricultural Commission, American Bankers Association, Madison, Wisc. 1935. 30¢.
Soil Conservation Districts for Erosion Control. Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 293. Oct. 1937. 10¢.[1]
Soil Conservation: A Philosopher's Viewpoint. Vermont Agricultural Extension Service, Burlington, Vt. Circular 97. Jan. 1938.
Soil Erosion, A Critical Problem in American Agriculture. Part V, Supplementary Report of the Land Planning Committee to National Resources Board. 1936. 75¢, paper-cover.[1]
Standard State Soil Conservation Districts Law. Soil Conservation Service, U. S. Department of Agriculture. 1936. 10¢.[1]
To Hold This Soil. Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 321. August 1938. 45¢, paper-cover.[1]
What Is Soil Erosion? Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 286. Feb. 1938. 15¢.[1]

Northeastern Region

Erosion Control in the Northeast. Soil Conservation Service, U. S. Department of Agriculture. Revised Oct. 1938.
Soil Defense in the Northeast. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1810. Sept. 1938. 15¢.[1]
Erosion and Related Land Use Conditions on the Scantic River Watershed, Connecticut-Massachusetts. Soil Conservation Service, U. S. Department of Agriculture. March 1939. 15¢.[1]
Permanent Loss to New England: Soil Erosion Resulting from the Hurricane. Reprint from the Geographical Review, Vol. XXIX, No. 2, April 1939. pp. 196–204.
Save New Jersey Soil. Bulletin No. 2. State Soil Conservation Committee. Extension Service, State College of Agriculture, Rutgers University, New Brunswick, N. J. March 1938.
Soil Erosion Survey of Pennsylvania. Bulletin 354. Pennsylvania State College Agricultural Experiment Station, State College, Pa., in cooperation with Soil Conservation Service, U. S. Department of Agriculture. Feb. 1938.

Southeastern Region

Soil Defense in the Piedmont. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1767. Jan. 1937, revised July 1938. 15¢.[1]
Wildlife Conservation Through Erosion Control in the Piedmont. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1788. Nov. 1937. 5¢.[1]
Erosion and Related Land Use Conditions on the Reedy Fork Demonstration Area, North Carolina. Soil Conservation Service. U. S. Department of Agriculture. 1938. 10¢.[1]
Early Erosion-Control Practices in Virginia. Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 256. March 1937, slightly revised July 1938. 10¢.[1]
Principles of Gully Erosion in the Piedmont of South Carolina. Soil Conservation Service. U. S. Department of Agriculture Technical Bulletin 633. Jan. 1939. 65¢.[1]
Soil Erosion Experiments. Vol. 35, No. 10b. University of Georgia, Athens, Ga. July 1935.

Ohio Valley Region

Anchoring Farmlands in the Ohio Valley Region. Soil Conservation Service, U. S. Department of Agriculture. Aug. 1937, slightly revised July 1938.
Conserving Corn Belt Soil. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1795. Nov. 1937. 15¢.[1]
Effect of Land Use and Management on Erosion. Bulletin 585. Agricultural Experiment Station, Wooster, Ohio. July 1937.
Soil Conservation in Indiana. Extension Bulletin 228. Purdue University in cooperation with Soil Conservation Service, U. S. Department of Agriculture. June 1938.
Soil Erosion and its Control. Circular 304. University of Kentucky, Lexington, Ky. July 1937.
Soil Erosion in the Karst Lands of Kentucky. Soil Conservation Service. U. S. Department of Agriculture Circular 490. Dec. 1938. 15¢.[1]
Soil Erosion in Michigan Orchards. Circular Bulletin 162. Michigan Agricultural Experiment Station. June 1937.
Soil Erosion in Ohio. Bulletin 589. Ohio Agricultural Experiment Station, Wooster, Ohio. Dec. 1937.

Western Gulf Region

Soil Defense in the South. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1809. Sept. 1938. 10¢.[1]
Erosion and its Control in Oklahoma Territory. Soil Conservation Service. U. S. Department of Agriculture Miscellaneous Publication 301. March 1938. 15¢.[1]
Erosion and Related Land Use Conditions on the Elm Creek Watershed, Texas. Soil Conservation Service, U. S. Department of Agriculture. Jan. 1939. 10¢.[1]
Erosion and Related Land Use Conditions on the Watershed of White Rock Reservoir near Dallas, Texas. Soil Conservation Service, U. S. Department of Agriculture. Feb. 1939. 20¢.[1]
Factors Influencing Runoff and Soil Erosion. Bulletin 411. Texas Agricultural Experiment Station, College Station, Texas. March 1930.

Upper Mississippi Region

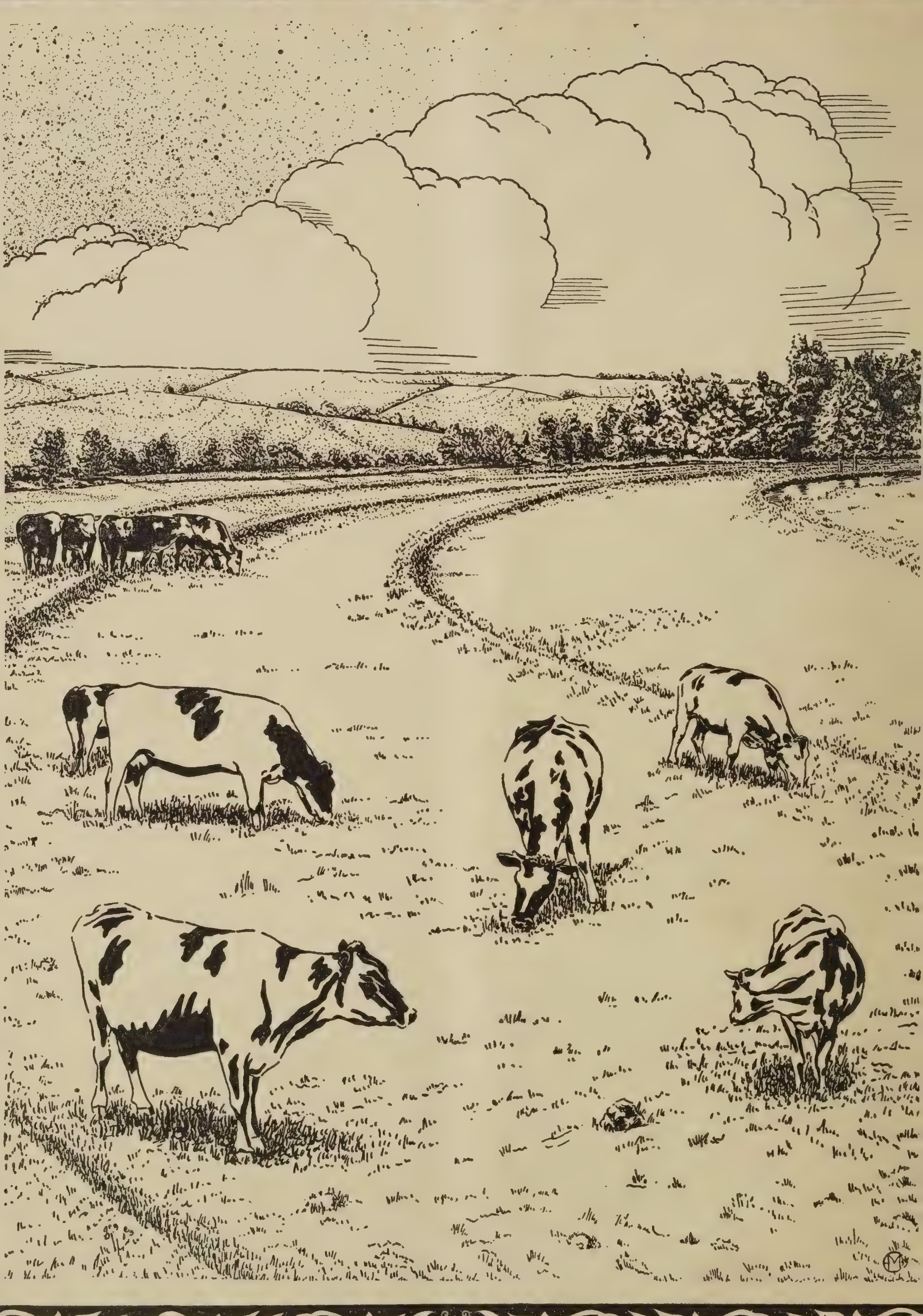
Conserving Corn Belt Soil. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1795. Nov. 1937. 15¢.[1]
From Ridge to River. Soil Conservation Service. U. S. Department of Agriculture. Feb. 1939. 5¢.[1]
Top Soil: Its Preservation. Soil Conservation Service. U. S. Department of Agriculture. Feb. 1937. 10¢.[1]
Cost of Soil Erosion with Control Suggestions. Illinois Farmers' Institute, Springfield, Ill. 1934.
Cropping Systems in Relation to Erosion Control. Bulletin 366. Agricultural Experiment Station, University of Missouri, Columbia, Mo. July 1936.
Economic Phases of Erosion Control in Southern Iowa and Northern Missouri. Bulletin 333. Agricultural Experiment Station, Ames, Iowa. June 1935.
Effect of the Degree of Slope and Rainfall Characteristics on Runoff and Soil Erosion. Research Bulletin 280. Agricultural Experiment Station, University of Missouri, Columbia, Mo. April 1938.
Erosion and Land Utilization in Wisconsin. Stencil Circular 153. Extension Service, College of Agriculture, Madison, Wisc. Oct. 1934.
Soil Conservation Districts—How Farmers can Organize them—How they Help Control Erosion. Circular 290. Extension Service, University of Wisconsin in cooperation with the State Soil Conservation Committee. August 1938.

List completed on p. 11)

---

[1] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

NOTE.—This list does not purport to be exhaustive. Other references are given in the lists contained in previous issues of "Soil Conservation."



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

AUGUST
1939

CONTENTS

Front cover by Adrian Clem
Back cover by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 2 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON AUGUST • 1939

THE ORGANIZATION MEETS THE PEOPLE ON THE LAND

By R. H. MUSSER [1]

BEHIND the welter of paper work—the letters, work plans, organization charts—lie concrete realities: The land and the people. Floods, erosion, and submarginal land are very real things. The rural slums that breed on impoverished, misused land are not theories. We must never let the paper on our desks obscure the hard, cold facts with which we have to deal. Never must we lose sight of our primary concern—the land and the people.

To do the job efficiently—with a minimum of useless paper manipulation and a maximum of actual field operation—is the purpose of the Service's organization, as I see it. And I see the Service with mud on its feet. I see the organization as a group of men actually at work on the land and with the people—men of youthful vision and good judgment whose feet are so definitely on the ground that they often sink a little way into it. These men have a sharp sense of reality. While they dream of things as they ought to be, in action they cope always with things as they are. They realize the necessity for paper work, for definite procedures and administrative channels, but they realize, too, that both the paper and the administrative set-up are of a facilitating nature, designed to accomplish certain tangible objectives in the field.

The Job To Be Done

Added duties and responsibilities granted the Service since October 6, 1938, now mean a consolidation in the Service of all erosion-control, water-facility, flood-control, submarginal-land purchase and development and farm-forestry activities of the Department in order to provide a comprehensive land-utilization and conservation service for all but forest and wildlife lands.

Thus, the Service's broadened field program includes many different lines of action—each with its own immediate objective. But it is evident, too, that these different lines of action have a common purpose: "The betterment of human welfare, the conservation of natural resources, the establishment of a permanent and balanced agriculture, and the reduction of the hazards of floods and siltation." Experience, observation, and common sense all dictate the wisdom of weaving the varied lines of action together into one strong fabric, thus avoiding duplication of effort, assuring community of action, and reducing overhead.

After all, the problems we face are not separate and distinct. In the field, we find that the problems and their probable solutions blend into each other so that it is hard to tell, for example, where erosion control leaves off and flood control begins, or where water

[1] Regional conservator, upper Mississippi region, Soil Conservation Service, Milwaukee, Wis.

conservation leaves off and the development of water facilities begins.

I have in mind our erosion control demonstration area in the Gilmore Creek watershed, just south of Winona, Minn. It is an effective demonstration chiefly for two reasons: (1) It is small and compact, including only 5,900 acres; and (2) all save one of the 56 farmers in the watershed have cooperated in the demonstration. Close to 100 percent of the area is now protected by contour strip-cropping, good crop rotations, the exclusion of grazing animals from timbered hillsides, the assignment of different use intensities for different areas. Twenty-nine soil-saving practices have been merged into a single protective program that practically blankets the area.

These practices have done a remarkable soil-saving job since their application, as the farmers themselves will tell you. The rate of accelerated erosion—formerly so serious that several farmers could plainly see the end of their farming careers just a few years ahead—has been reduced to a small fraction of its old speed. But the benefits of the program cannot be measured entirely in terms of soil saved, for they extend also to the control of floods in lower Gilmore Valley and to the reduction of siltation in Lake Winona, into which Gilmore Creek drains.

Let me cite an example. On June 19, 1937, a rain of approximately 1.7 inches fell in about 1 hour's time in the Gilmore Creek watershed and surrounding areas, climaxing a series of rains which had left the soil well saturated. Investigations conducted by Soil Conservation Service staff members immediately after the rain revealed that, while considerable flood damage had been done in Pleasant Valley, West Burns Valley, and other neighboring watersheds, no flood at all had occurred in Gilmore Valley. The neighboring streams had gone out of their banks while Gilmore Creek had no more than half filled its channel.

Despite the intensity of the rain, the erosion damage in Gilmore Valley's strip-cropped fields was relatively slight—less than the damage formerly caused by rains of one-fourth that intensity. Silt being carried into Lake Winona by the flood waters from the watershed was markedly less in volume than that poured down after storms much less severe before the demonstration was started.

Thus, during that one storm the soil-erosion control program not only saved soil but also reduced run-off, prevented a serious flood, and protected a city's resort lake against the clogging effects of erosion debris.

Similarly, in the soil-conservation demonstration project near Carbondale, Ill.—where a dam across Crab Orchard Creek will form a 6,900-acre lake, and land unsuited to agriculture has been acquired by the government for other uses—the farm conservation plans already in operation there collectively accomplish several supposedly "different" objectives. These farm conservation plans have been formulated in keeping with a program wherein submarginal land has been retired from cultivation; erosion on uplands is being controlled through tree plantings and small gully control structures; reduction of erosion will reduce lake siltation; and—eventually—land developed by the government for pasture may be leased to neighboring farmers to supplement existing farm units.

Organizing To Do the Job

The nature of the job to be done—the fact that in the field are a number of work programs tending to

Group of farmers in the Burns-Homer-Pleasant soil conservation district listening to Conservationist Stanley explaining a map from which a soil conservation plan will be developed.

Panel discussion of complete farm plan on Harry Debes farm, in Iowa. Forty-eight cooperators and 145 others participated in a series of 7 meetings held in the Farmersburg-McGregor project early in 1939.

merge into each other and that the same techniques are employed to achieve different immediate objectives—has in a large measure determined the form of Soil Conservation Service organization.

Study our field activities and you will notice that the several work programs—erosion control, water facilities, etc.—have more in common than the different techniques employed *within* those programs. What I mean is that erosion and water facilities, as separate programs, resemble each other more closely than do, say, the techniques of engineering and forestry. Moreover, these *same* techniques of engineering and forestry are employed in *both* programs. Similarly, the submarginal-land development and erosion-control programs resemble each other more closely than do agronomy and wildlife management, but *both* agronomy and wildlife management are employed in the two work programs.

Given, then, (*a*) *similar work programs sharing common broad objectives* and (*b*) a *multiplicity of widely differing techniques*, how should the Soil Conservation Service be organized? Thus the organization problem has been presented to us, and in solving it we have elected to develop a *functional* type of organization rather than a *program* type. We have classified our personnel and determined our different administrative units on the basis of functions rather than on the basis of programs. Since the technique of tree planting is the same—whether the tree be planted for erosion control, flood control, or submarginal-land development—we let the same men administer the tree-planting work for all three programs. The same is true of agronomy, soils, wildlife management, engineering, farm management, and information and education. Thus the different programs are integrated—tied together in one program—and duplication of effort is reduced to a minimum. Then, too, the problem of coordinating the inner workings of the Service is much simpler in a functional type of organization than it would be in a program type.

Such an organization is flexible—readily adaptable to the varying needs of different areas—and it is capable of assuming an almost unlimited number of additional duties and responsibilities. If we were asked to administer a vastly expanded flood control program we would be forced to add personnel, of course; but the present form of our organization would remain the same. And that form is such that practically all of the funds assigned to us for the expanded program could be passed on to the field and used there in actual field operations.

That is another great advantage of our form of organization—the fact that expansion of our programs will inevitably mean a reduction in the percentage of total costs assigned to overhead. In this regard the functional type of organization differs greatly from the program type. If we were to proceed on a program basis, the relative costs of administration and operations within each program would be quite definitely fixed, and as additional work was assigned to us overhead costs would necessarily advance at the same rate as operations costs. As it is, absorption of a new program is likely to result in a revision of that program's

budget with a view to cutting administrative costs to a fraction of their former figure while increasing the funds available for work in the field.

Our organization might be compared to a pyramid, with the upper portion representing administrative overhead and the base representing the spread of actual field operations. In the beginning, the pyramid was tall and slender; it resembled the trylon of the New York World's Fair. Its walls, which were then flat surfaces, slanted only slightly as they reached from the ground to the pinnacle. But as the organization grew and additional programs assigned to us were broken down and distributed through functional units, the pyramid's base became broader and its walls more concave and gently sloping. Instead of a group of pyramids, each representing a separate program and each with a definite apex portion assigned to overhead, we now have *one* pyramid in which the apex or "overhead" portion has not expanded at anywhere near the same rate as the base of the pyramid.

As the Service grows, the relative size of the different parts varies, but the essential form remains unchanged. Our tendency is not toward more and more rigidly centralized control of all activities, but rather toward a *decentralization* of control.

The functional type of organization is carried down through the four levels of authority—from the Washington level, through the regional office level, to the area level, and thence to the work units in the field. At each of the first two levels, only as much authority has been retained as is absolutely necessary to assure proper coordination of activities, adherence to established policies, and general efficiency of performance. Every effort has been made to pass as much responsibility as possible on to the field units, so that local personnel will have the necessary freedom to deal promptly and effectively with local situations.

Establishment of the area office set-up was of special significance in this regard. Not only should this change cut overhead costs by reducing the number of administrative units, but it also should increase the amount of administrative authority in the field. As time goes on, and we all become increasingly aware of the broad purposes of our work and of the policies governing it, more and more freedom for self-determination is going to be exercised by field offices.

The Washington office functions in the determination of programs and policies; the regional offices function in the distribution, interpretation, and application of programs and policies, and determine Regional policies based on Service policies; the areas distribute and apply programs and policies; the work units execute programs in accordance with established policies. But in action, the flow of material through administrative lines is by no means one-way. In action, the administrative lines not only tie the organization together but also operate as a sort of circulatory system. Ideas and information gained from practical experience with the job on the ground flow up from work units through administrative channels to the upper levels of authority. There they are sifted and examined, and those found valid flow back down through administrative channels as policies, procedures, and approved programs.

Cooperation With Other Agencies

I am personally convinced that we have the most efficient type of organization for our kind of work. It points straight at that ideal of all organizations handling action programs: A minimum overhead and a maximum spread at the point of application. But no organization—no matter how streamlined—can be more efficient than its personnel. It is the quality of personnel that determines the quality of performance at every point.

But the Service alone cannot give farmers all the assistance they need to solve the land-use problems that confront America today. Cooperation with other agencies dealing with land-use problems is essential.

One of the chief responsibilities of the Service is the coordination of programs within itself and with relation to the programs of other agricultural agencies. Therefore, in our organization we have placed upon the State coordinators—under the administrative direction of the Regional Conservator—the job of fitting our functioning programs to the desires and needs of the States. The coordinators not only couple our work with the work of State agencies but also aid in actual program development and in the determination of policies and procedures within the Service itself.

The State coordinators are the "eyes and ears" of the Service. They are active contact or liaison men. Their offices are channels through which flows a major portion of the contacts between the Service and other agencies working in the States.

All along the line, provisions have been made for cooperation between the Service and other agencies, and in action the Service *does* work closely with many different institutions and groups. Take, for example, the submarginal-land purchase program now underway in 24 northern Wisconsin counties. The Service's land acquisition division has been buying land with funds appropriated under title III of the Bankhead-Jones Act.

But in determining what land to purchase, the Service has been working in the closest cooperation with State and county agencies and other Federal agencies. For instance, no land is being purchased outside the areas zoned against agricultural use by the counties. This is in accordance with Wisconsin's zoning law. County agricultural planning groups and the State college of agriculture aid in determining the priorities for purchase of the various tracts put up for sale. Every effort is made to coordinate the Service's purchase program with the rural rehabilitation program of the Farm Security Administration, so that farm families moving off submarginal land will have somewhere to go, with a new chance to "make good."

Further examples of cooperation between the Service and other State and Federal agencies are furnished by the flood-control surveys now underway in the watersheds designated by the Omnibus Flood Control Act. Here the Service joins with the Forest Service and the Bureau of Agricultural Economics, and in consultation with State agencies determines (1) whether circumstances warrant the establishment of a land-use program for flood-control purposes, and (2) if so, the general type of upstream program needed to do the job.

Important among the agencies with which we cooperate are the State colleges of agriculture, the State extension services, and the State experiment stations. State advisory committees, each composed of the administrators of these agencies, particularly the latter two, and the State coordinator have been responsible for formulating the State soil conservation program.

Cooperative extension agents are employed jointly by the Service and the State extension services to give leadership and supervision to the educational program in soil and water conservation in the State. Service technicians work in the closest cooperation with college subject-matter specialists, sharing with them information and practical experiences which may improve the programs of both institutions. And all informational and educational materials originating in the Service and used by it clear through college extension editors.

The Service also cooperates in fruitful ways with State conservation commissions, State departments of agriculture, and vocational agriculture teachers. In recent months there has been a considerable increase in active cooperation between the Service and local schools. Numerous training schools have been held to give vocational agriculture teachers and others working in the educational field detailed information concerning erosion-control practices. And for years now the Service has been making the most of its opportunity to give enrollees in C. C. C. camps assigned to us practical courses in the various phases of soil conservation.

The Service has an outward look. At every point in the field the Service seeks to cooperate in land-use programs promising immediate and long-term benefits to the farmer.

The Organization at Work

So far I have talked mostly about the inner workings of the organization and the manner in which it cooperates with other Federal and State agencies. I have tried to show how the work in the field has presented the pattern on which our organization has been molded. I have tried to show the reasons, in terms of flexibility and administrative efficiency, for the form our organization has taken. Now I should like to have you look with me at the Service from another standpoint—from the standpoint of the people and the land.

On the land we deal with is the farmer, Pete Olsen. Pete has a farm inside the boundaries of a certain demonstration project. He had been bucking the erosion problem for years, and he jumped at the chance to get help in solving his problem. He signed up, became a cooperator in the demonstration program. His farm was mapped. Service technicians and Pete worked together developing a farm plan that employed all the functions of the Service needed to do the soil-saving job. Engineers helped him build terraces and gully-control structures. Agronomists helped him work out cropping systems and soil-management plans. Foresters helped him get trees planted and a woodland management plan started. And, shortly, Pete found himself on top of his erosion problem for the first time.

Techniques, originating in the various functional units of the Service, flowed down along administrative channels through the various levels of authority and poured out, smoothly and efficiently, over every acre of Pete's farm. There they united in a complete, tangible farm program which Pete himself helped plan and apply.

That was 5 years ago. Today Pete's land-use problems are pretty well licked.

But some of Pete's neighbors are not so fortunate. There are quite a few farmers in his community who, for some reason or other, did not cooperate in the demonstration. Today, I believe they look with envious eyes on Pete's well-kept land and are acutely aware of the gullies crawling through their own sloping fields. Several of them are trying to copy Pete's program, but they are having their troubles and need some help in making complete farm conservation plans.

They are anxious, now, to "join up." They have numerous battles to fight against floods, against the poverty which rides down those who operate submarginal farms, and even against a rising water table that drowns crops and pastures in the low bottomlands. They need, and want, a coordinated attack on their various physical enemies for they realize that these destructive forces are closely allied.

So Pete Olsen and his neighbors are organizing a soil conservation district. They live—fortunately—in one of the 36 States that have passed conservation districts laws, and they are determined to take full advantage of the facilities that can be made available to them through district organization.

A few weeks ago, district supervisors were elected—Pete, incidentally, is chairman of the board—and a program and work plan have been drawn up. The county land-use planning committee and representatives of local State and Federal agencies assisted the district supervisors in this undertaking. The supervisors are now asking the Service to furnish technical assistance. The State college, the county agent, various State and local conservation organizations, as well as individual farmers, are cooperating with the district toward attaining a wise land use. Every day, more farmers are coming in to the district office, anxious to get some help in making their farm conservation plans. As a cooperative enterprise, the district is rapidly effecting soil conservation.

Now, the story of Pete and his neighbors points a moral—and a highly important one. In Pete's neighborhood, the job—considered from the standpoint of the land itself—is one of use adjustment. We are dealing there with land resources. Our job is to help these farmers plan for a reasonable living from these resources, using the income and conserving the capital.

But we, as a Service, and other agencies went ahead with the control program only after Pete and his neighbors showed us the green light—and they are still directing the traffic. This Service and the Extension Service brought to the people the facts about land abuse and the correction of it. We offered to them, insofar as we could, the Department's facilities. After that it was up to the people themselves. They have shaped an organization through which they can harness and employ for their own use technical energies which would otherwise be diverted into other channels.

The Soil Conservation District

The case of Pete and his neighbors is, I think, typical—and therefore significant. Out of the recent rapid expansion of Department activities, the conservation district is gradually emerging as the key to our field programs. We are working with an increasing number of people through organizations of their own. In the Soil Conservation Service, for example, we find more and more of our lines of action reaching down, fusing with activities and concepts coming up from the ground itself, and thus forming the programs and work plans of soil conservation districts. Or, to put it another way, we find groups of people with mutual land-use problems banding together, working out plans for the solution of their problems, and then reaching out toward the Service and other agencies for the help they require. It is a healthy development. Farm people are getting a more efficient distribution of the available technical and material aids, and at the same time tapping almost unlimited resources of energy, ideas, enthusiasms.

The Service—its programs broken down and coordinated on a functional basis—finds in the district a natural medium through which it can reach the people to assist them in planning and solving their land-use problems. The district's activities, it should be remembered, are by no means confined to soil and water conservation. Upstream flood control, submarginal-land purchase and development, the development of water facilities, drainage and irrigation, farm forestry—all of these programs can be effectively carried out through districts. So, perhaps, can the programs of other agencies—the Agricultural college, the F. S. A., the A. A. A., State Departments of Forestry and Conservation dealing with social and economic aspects of the land-use problem. The district, then, is turning out to be a very practical tool for bringing order out of chaos; it clarifies our thinking, gives more purposeful direction to action programs, provides a focal point on which all efforts converge.

But this concept is likely to have small meaning for us unless we couple with it the concept of the "problem area"—and in clarifying this latter concept for myself I like to direct my thinking toward actual situations which I have encountered in the field.

I find myself unconsciously picturing in my mind the country which lies along the Mississippi in southwestern Wisconsin, southeastern Minnesota, northeastern Iowa, and northwestern Illinois. Ages ago, when the great glacier spread down over mid-America, this area was for some reason left untouched. While masses of moving ice scooped out lake beds and ground down hills in the surrounding areas, this one spot stood out—stark and bare—as an island in a frozen sea. Consequently the hills today are higher

and steeper here than they are in surrounding areas and the soil—a windblown loess deposited after the retreat of the ice—is more susceptible to erosion damage than most soils. All through the area we find sharply defined small watersheds with relatively narrow ridges and valleys—both of which are customarily farmed—separated by steep, timbered valley walls.

And in the watersheds the scars of land mis-use are clearly evident. Scattered through most of them are numerous spots where sloping ridgeland fields are gashed with gullies and rich bottomlands are buried under erosion debris. In these watersheds we find, in intensified form, the problems of accelerated erosion and increasing floods. We find, too, a gradual but unmistakable decline in land capabilities and an increase in the number of farms which are no longer profitable economic units. Fortunately, desolation is not so far advanced that the area cannot be saved for future agricultural use. But throughout the 17,000,000 acres the problems of erosion control, land-use adjustment, and flood control are acute—while submarginal-land retirement and development are emergent problems.

Here, then, is a sample problem area. For the most part the farms within it have a common soil type, a common topography, and a comman land-use pattern (dairying and livestock production are the principal farm enterprises). In other words, the farmers in the area have a common physical environment and they are, most of them, trying to manipulate that environment in about the same way. Hence, a land-use program that is good for one farm in the area is likely to be good—so far as essential features are concerned—for all other farms. The farmers have a physical and economic basis for broad-gage planning. In the circumstances, what is more natural than that farmers should link themselves together with a view to attaining objectives that could not be attained through isolated individual efforts?

The districts are for mutual assistance, and I am happy to say that quite a number of them are being organized—most of them along watershed lines—in the area I have cited. Eight hundred and forty-two thousand acres are included in the actually established districts, and it looks as though the entire unglaciated area soon will be covered by them.

The district has barely begun to do the job it is designed to do. But four out of the five States in Region 5 now have the necessary enabling legislation.

Most of the field programs in this region are still being carried on through erosion-control C. C. C. camps, drainage C. C. C. camps, erosion-control demonstration project areas, and submarginal land projects. But the district, as I say, is the coming thing and well worth stressing for that reason. It seems inevitable that eventually all our work units will be included in or identified with these organizations of the people on the land.

The district, then, is the doorway through which we enter the future. It is one of the doorways through which the transition is being made from the exploitive, competitive agriculture of the past to the cooperative, conserving agriculture of the future. And the thing I like best about the doorway is its architecture, which is unmistakably American. Designed in accordance with American traditions and practices, democratic in conception, the district stands firmly grounded in the good American earth.

FOLLOW THE CONTOUR AND IMPROVE THE MEADOWS

By R. W. GERDEL [1]

ANY FARMER would gladly perform simple conservation practices if he knew that he could reduce soil losses in his cornfield from 98 tons to less than 4 tons per acre per year.

Such remarkable reduction in deposited soil losses actually was accomplished on strip-cropped fields in the Salt Creek demonstration area, Zanesville, Ohio, within three growing seasons. Reduction in soil losses seems largely the result of two conditions, (1) improvement in contour adherence of the cultivated strip and (2) better meadows resulting from a correct fertility program.

The figures showing that soil losses were reduced to this extent are taken from strip-cropping investigations made during the years 1936, 1937, and 1938.[2] Evident erosion in corn strips was determined by measurement of the volume of soil in the colluvial fans deposited in

[1] Assistant soil conservationist, Soil Conservation Service, Dayton, Ohio.

[2] The Divisions of Operations and Research of the Soil Conservation Service and the Ohio Agricultural Experiment Station cooperating.

The contour strip-cropped fields on one of the farms where deposited soil losses were measured.

meadow strips below the corn. Measurements were made on two adjacent farms whose owners are Soil Conservation Service cooperators. Soil losses measured in 1936 and 1938 were in the same fields although in different strips of the 4-year crop rotation system in use. The measurements in 1937 were made in different fields on the same farms, because of the two-unit strip-cropping system in effect.

The photograph shows strip-cropped fields on the Floyd Lapp farm, one of the two where measurements were made. Average deposited soil losses for each year as shown in table 1 were influenced by such variables as contour adherence, steepness of slope and length of slope. Since different fields were involved in the measurements for 1937 and 1938, the significance of the difference between the deposited soil losses for these 2 years was tested by Fisher's [3] method on selected strips, homogeneous for length and steepness of slope and contour adherence, from each field. The difference was found to be highly significant.

A comparison of the deposited soil losses for the 3 years indicated a remarkable improvement in the erosion control effectiveness of strip cropping as the full conservation program developed on these farms. The reduction in evident erosion on these strips, from 98.3 tons of soil per acre in 1936 to 34.8 tons of soil in 1937, with still further reduction to a loss of only 3.7 tons per acre in 1938, not only reflects the improvement in contour adherence, but also indicates the improvement in the meadows resulting from a good fertility program.

[3] Fisher, R. A.: Statistical Methods for Research Workers, 5th edition. Edinburgh, 1934.

Improvement in contour adherence of the strips was achieved by increasing the width of the numerous sod waterways which bisected these strip-cropped fields. Carrying the sod up over the shoulder of the drainageway greatly reduced the amount of divergence from the contour which had previously resulted from planting corn down the sides of the draw to the sodway left in the bottom of the depression.

Observations indicated that in addition to the improvement in contour adherence, a large portion of the reduction in evident erosion, from 98 tons of soil per acre in 1936 to approximately 4 tons in 1938, could be attributed to the improvement in the organic-matter content and fertility level of the soil. The strips planted in corn in 1936 were plowed out of a poor poverty-grass sod. The use of lime, fertilizer, and a good grass-and-legume seed mixture, with small grain as a nurse crop, resulted in rapid improvement of the meadows. By the spring of 1938, an excellent quality of vegetation was plowed down for the corn crop.

Although the project was not equipped to determine the organic content or fertility level, all observations indicated a considerable increase in the humus and nutrient content of the soil in these strip-cropped fields by 1938.

This remarkable improvement in the effectiveness of strip cropping is emphasized when the results of these studies are compared with data from the Northwest Appalachian Soil and Water Conservation Experiment Station near Zanesville. At this station, a greater soil loss was obtained in 1938 than in 1936 or 1937 from corn grown in rotation as shown in table 1.

Table 1.—*Deposited soil losses from corn strips on 2 adjacent farms of cooperators in the Salt Creek project area and soil losses from rotation corn plots at the Northwest Appalachian Soil and Water Conservation Experiment Station, Zanesville, Ohio*

Year	Lapp and Gosser farms			Experiment station	
	Percentage of contour divergence	Rainfall [1]	Soil loss	Rainfall [1]	Soil loss
	Percent	*Inches*	*Tons per acre*	*Inches*	*Tons per acre*
1936	6.5	18.61	98.3	17.09	54.3
1937	4.2	23.28	34.8	19.40	41.9
1938	3.5	21.65	3.7	22.24	72 6

[1] Total rainfall for growing season, May to September, inclusive.

Note.—For 6 strips from the 1937, and 6 from the 1938 data homogeneous for watershed, slope, and contour adherence, $D=20.7\pm5.8$, $t=3.56$. Degrees of freedom$=10$. The difference is highly significant.

Table 2.—*Precipitation during the growing season at the Northwest Appalachian Soil and Water Conservation Experiment Station, Zanesville, Ohio, and the E. H. Gosser farm, Salt Creek project*

Year	Location	May	June	July	August	September	Total
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1936	Experiment Station	1.98	1.37	6.09	4.89	2.76	17.09
	Gosser farm	3.09	1.70	5.19	4.76	3.87	18.61
1937	Experiment station	4.55	6.85	2.84	3.63	1.53	19.40
	Gosser farm	4.35	7.83	5.78	3.66	1.66	23.28
1938	Experiment station	6.61	4.72	2.43	3.85	4.63	22.24
	Gosser farm	6.43	4.64	3.20	3.43	3.95	21.65

Comparison of the seasonal rainfall at the experiment station and at one of these two farms where a rain gage is located (see table 2) does not indicate sufficient differences in precipitation to influence the results.

It appears that the achievement of a satisfactory contour adherence and the development of high quality meadow strips through the use of lime, fertilizer, and good seed mixtures will materially improve the erosion control value of strip cropping. Although such remarkable improvement may not always be obtained, the results in this instance indicate that reasonable improvement in erosion control may be expected under most conditions as the farmer's complete farm-planning program approaches full development.

THE FARMERS ARE HEARD FROM

By BUSHROD W. ALLIN [1]

THE VOICE of the farmer is being heard in the land, through county planning committees, for the first time since the Secretary last October directed reorganization of the Department of Agriculture.

One of the primary aims of that reorganization was to provide a channel whereby farmer opinion could influence national agricultural programs and whereby technical opinion could be made available to farmers in wrestling with their local problems.

In the months since the Secretary's order was issued, the land grant colleges and the Bureau of Agricultural Economics have been working energetically toward making a reality of the aims outlined in that order.

And now the first fruits of this work are becoming apparent. Farmer-drawn recommendations are beginning to arrive in Washington. Two of these sets of proposals are from Hill County, Tex., and Sonoma County, Calif., both classed as "intensive" counties, in the terminology of the county planning project. Such counties are those in which the planning is preliminary to that being done in the counties known as "unified program" counties.

"Intensive" counties are counties in which the farmers have gone a long way toward outlining a plan whereby they believe the national farm programs in their counties can be advantageously altered, counties where farmers are already tackling some of the other problems that do not call for changes in Federal action programs. So much for the "intensive" counties. On the other hand, "unified" counties are those counties where it is expected it will be possible for the action agencies to reflect this farmer opinion in their programs for 1940, and where a major effort at reconciling local, State, and Federal programs will be made next year.

The recommendations from these two county committees—one in California and one in Texas—are interesting for many reasons, aside from their being among the first to reach us in Washington. The broad scope of problems and solutions with which they deal, and the frankness with which they go into their own situation and the possibilities for change, cannot but be regarded as hopeful signs for the future.

Suppose we look at some of the specific recommendations of these committees, taking Sonoma County, Calif., first.

The Sonoma County committee felt that a detailed soil survey of the county should be undertaken by the Department of Agriculture and the Soils Division of the University of California. It also urged that an investigation of the suitability of new crops that might be produced in various sections of the county would be desirable, recommending that a committee of five

[1] Head, Division of State and Local Planning, Bureau of Agricultural Economics, Washington, D. C.

members be appointed by the farm advisor to look into the possibility of introducing such newcomers as ladino clover, grain and fodder crops, and to work out desirable field crop rotations for various sections of the county.

The extensive demand in the local markets for cereals, particularly wheat, barley, and oats, led to the suggestion that more of these grains could be profitably grown in the county. To accomplish this, it recommended: (1) that an adequate supply of black oat seed be developed; (2) that the rust-proof red oat seed supply be improved by the introduction of a rust-proof resistant strain; (3) that the local bluestem wheat seed supply be improved by the introduction of a smut resistant strain; (4) that limited early fall planting trials of "Vaughan" variety of barley be made.

Noting that in some parts of the county the water supply is inadequate, the committee recommended water development by the Soil Conservation Service, the Bureau of Agricultural Economics, and the Farm Security Administration under the Water Facilities Act.

Eroded areas on steeply rolling hay and grain lands, it was believed, could be substantially protected from further washing by diversion from hay and grains to suitable grasses. The committee suggested that range reseeding trials be conducted, including reseeding of a trial plot of range by airplane, this work to be undertaken cooperatively by range operators, the State Forest Service, the Agricultural Extension Service, the agronomy division of the University of California and the Department of Agriculture.

It asked, too, that the County Agricultural Extension Service and the Soil Conservation Service continue work now under way on range grass nursery plots, and that as soon as possible more such experimental plots be started by them. To further deferred grazing on the range land of the county, it advocated continuation of A. A. A. payments for such deferred grazing.

Turning to forestry aspects of its report, to preserve and possibly increase the range areas of the county, it suggested the need for continued experimentation by the State division of forestry and the Forest Service, or by the latter alone, to determine under what conditions controlled burning of mountainous brush areas is desirable.

The committee recommended the preservation of the remaining virgin stands of redwood lumber in the county, and to that end the acquisition by the Government at a reasonable cost of a designated area as a part of the proposed Mendocino Coast Recreational Forest. The importance of Sonoma County's timber and brush-covered areas as recreational regions and "watershed supplies" for the increasing population, the committee felt, renders fire control of vital significance.

It therefore recommended the extended use of C. C. C. workmen in building roads through these areas and for fire suppression. It thought that the development of livestock should be encouraged in order to promote better use of land, suggesting appointment of a livestock committee charged with formulating proposals for better marketing facilities within the county.

As to water problems, the committee noted that preliminary examinations of the flood control situation in the Russian River Basin have been completed by the Secretary of War and the Secretary of Agriculture, and strongly recommended that these agencies give favorable consideration to the Russian River Basin flood control project. Further orderly development of means of irrigation is desirable throughout the county, the committee also believed, recommending (1) that the Agricultural Extension Service continue its survey on underground water supplies of the county in order to determine what changes are taking place in the water levels from year to year; and (2) that further information be obtained and made available as to financial, engineering, and other assistance available to persons and groups under the Water Facilities Act.

No less specific were the recommendations that emerged in the preliminary report from Hill County, Tex. Although the county was divided into seven areas by the committee, one area covers more than 54 percent of the total county area. The committee listed these as the important agricultural requirements of this area: (1) Expansion of the farm water supply, since about 50 percent of the farms do not have sufficient water; (2) control of erosion in that region of high rainfall, and sloping land, where a crumbly calcareous soil planted largely to cotton and corn make erosion a grave problem; (3) root rot control, since an estimated 25 percent of the cropland in the area already is infested with cotton root rot; (4) production of a sufficient quantity of food and feed for home use, inasmuch as too large a percentage of the land is planted in cotton while the acreage in pasture, feed, crops, gardens, and orchards is too small; (5) pasture improvement.

Outlining its recommended cropping system and livestock organization, the committee set the size of the recommended farm at 150 acres, as opposed to the

1937 average of 136 acres. It placed less emphasis on cotton in the recommended farm, although it thought the acres in cotton per farm should be about the same. Specifically, it asked a decrease in cotton for the area as a whole of 13 percent, which with some additional acreage now in idle cropland and miscellaneous crops, would allow for recommended increases in feed crops and Sudan pasture, home gardens and orchards and permanent pasture and farmstead. Under its recommendations, workstock and beef cows would be eliminated, although other classes of livestock in the area would be increased.

The committee listed these recommended conservation practices for the area:

1. All the cropland (with the exception of small overflow bottoms) needs terracing, for only about 15 percent of the land in cultivation is properly terraced;

2. Cotton and feed should be planted in alternate strips on the contour, a practice designed to reduce damage from cotton fleahopper as well as to minimize erosion.

3. Corn should be interplanted with peas or Hubam, either through alternation of two rows of corn and two rows of peas, or four rows of corn and four of peas. After corn is harvested, the entire acreage should be turned under while peas are green;

4. Fields, excepting corn, should be grazed after harvest;

5. Small natural drainageways, especially those that are eroding, call for: (*a*) Terracing if badly eroded, and otherwise solid contour listing; (*b*) establishment of improved varieties of pasture plants such as dallis grass, buffalo grass, and burr clover; (*c*) fencing the pasture for livestock, and if it is not adjacent to the farmstead, a connecting lane. A trench silo was recommended on farms where there is a well-drained spot and where the soil is not likely to become too moist or the sides to slide during rainy seasons.

Other areas in Hill County called forth such additional recommendations as that for provision of loans at low interest rates "without red tape;" improved housing facilities, roads and schools; lease agreements to give more security to the tenant; disposal of crop residue; insect control.

These counties—Hill County, Tex., and Sonoma County, Calif.—are demonstrating the new way of democratic participation in planning, whether local, State, or national. Their recommendations are explicit expressions of the farmer's point of view, and are interesting to people concerned with county planning as a hint of what a broad program of planning can mean.

COUNTY GROUP PLANNING

COMMUNITY EDUCATION for soil conservation as the logical approach in starting a new project has been proved on the Grand Traverse, Mich., project.

In 1938 the county land-use planning committee met to discuss the need for a soil conservation program in this cherry-producing section. Then in January 1939 a series of educational meetings was held to describe soil conservation work on other projects and districts in Michigan. At these meetings there was no public intimation that a project might be established.

Later the land-use planning committee, consisting of 15 members, met with the county agent, State coordinator, and extension soil conservationist to discuss the functions of a soil-conservation project. The committee voted unanimously for the establishment of a project. They limited demonstrations to 50 or 60 farms in the area and agreed that only technical services would be required in the development of the project.

APPROVAL for the establishment of the demonstration area was obtained from the Secretary of Agriculture in April. An executive advisory committee was selected, to arrange agreements with all cooperators in the area who were anxious to have their farms planned for soil conservation. The committee also made the arrangements for project headquarters. The farmers in the area participated in the planning. A trip was arranged to the nearest Soil Conservation Service project, some 200 miles distant, at Benton Harbor where conditions were similar to those of the Grand Traverse area.

"Project technicians were made available to plan the farms, but the local committee continued to function," E. C. Sackrider, State coordinator for the Service in Michigan, stated. "Farmer participation in the development of programs is the logical approach to obtain desired cooperation. A number of requests have been received from the adjoining county for a series of educational meetings to discuss soil conservation and to explain the Soil Conservation Districts Law."

CHOOSE SUPERIOR LOCUST STANDS FOR SEED COLLECTION

By JOHN W. SITES [1]

PROBABLY at no other time in the history of the United States has any single species of tree been so widely planted or generally acclaimed for use in land reclamation as has black locust (*Robinia pseudoacacia*) during the past few years. Millions of these trees have been planted in the Ohio Valley region alone, and the total for the Nation approaches a billion. During this short time thousands of pounds of seed have been collected and planted in nurseries for the production of seedling stock. Seed and seedlings have been shipped to all parts of the United States *with too little thought having been given to their origin.*

Nurserymen and foresters alike have spent considerable time perfecting methods for the various operations and to improve techniques. When one looks into it, however, and sees what little attention has been given to the matter of seed collecting from preferable sources, all this seems decidedly inconsistent. Probably no other single operation well done would contribute so much toward successful plantations as careful consideration of parent stock. At a conference of Pennsylvania foresters, George S. Perry, research forester for Pennsylvania, expressed a thought well worth repeating: "Forests of the future can be at best but little better than their heredity."

It is for the most part recognized, although vaguely understood, that in collecting seed for use as propagating material, reasonable care should be given to the selection of the parent trees. But in far too many instances this is easily forgotten, especially in the collection of locust seed when large quantities must be gathered quickly.

Locust trees in general seem to exhibit a tendency toward considerable variations in habit of growth. In many instances the reason for this variation seems to be genetical, and not too closely associated with environmental influences. There are few communities which do not have at least one outstanding grove of locust trees. The straightness of the trunk, the absence of conspicuous side branches and forks close to the ground, rapidity of growth, and general thrifty condition of the trees are characteristics which are easily recognized; and, as a rule, such a grove presents quite a contrast to the average locust in a particular community. A closer examination of the soil and other conditions will help to determine whether or not the cause is entirely environmental or whether these trees are genetically different from others in the community. Often the owner knows the history of the trees, and enlightening information can be obtained from him. It is not a difficult task for any technician to make note of stands which look promising and later to advise those concerned with observational studies so that they may make more detailed investigations. By such simple means superior stands of locust trees can be charted for subsequent use as sources of seed. Particularly desirable stands should be reported to the regional nurseryman so that, if warranted, vegetative propagation can be employed.

It is not to be presumed that simply by the mass selection and collection of seed from superior type stands will all of the progeny resulting therefrom exhibit these identical characteristics. It is reasonable to assume, however, that, by and large, these young stands will in a few years develop characteristics superior to the average trees in the community.

Newly reclaimed areas are most satisfactorily established by planting seedling stock, and from these plantings natural regeneration will continue. J. A. Larsen [2] has demonstrated the fact that natural regeneration of locust occurs in most cases by means of root suckers. This, of course, means that these plants have characteristics identical with those from which they originated. Surely, from the standpoint of heredity, this emphasizes the desirability of planting only the best stock obtainable. We cannot be excused for perpetuating inferior type locust trees; and certainly, only good can result from a correctly executed seed-collection and planting program.

Within the Ohio Valley region several exceptional stands of black locust have been observed. It has been the policy, thus far, to select from these groves one particular tree which seems superior to the others and to propagate vegetatively by means of root or stem cuttings, from this individual, small numbers of plants for further study. By such means all progeny is traceable to one parent plant.

In addition, all seed possible is collected from these stands, is assigned an accession number, and used for

[1] Assistant regional nurseryman, Soil Conservation Service, Dayton, Ohio.

[2] Larsen, J. A.: Natural Spreading of Planted Black Locust in Southeastern Ohio. Journal of Forestry, June 1935.

(Continued on p. 43)

Tree Types as a Guide for Seed Collection

Second growth from root suckers after clearing, 45 years ago.

This superior *Type Stand* at "Locust Grove Church," New Lisbon, Indiana, clearly illustrates reproduction by root suckers. Note the resemblance of young trees to parent *Type*.

Remnant of original planting made 80 years ago.

These trees growing along Route U. S. 23 South of Alma, Ohio, are typical of desirable types.

Such undesirable characteristics should not be perpetuated

This grove located close to Howell, Michigan, is from 25 to 40 years old. Trees from this stand have an excellent reputation for straight splitting.

RANGE MANAGEMENT BRINGS SUCCESS TO ISLETA INDIANS

By DEWEY DISMUKE [1]

Diego Abeyta, Pablo Abeyta, and Esquipula Jojola, three Isleta Indians designated by the Commissioner of Indian Affairs as trustees of the community cattle herd. They have held office since their appointment in 1936, and have cooperated with the Soil Conservation Service in the management of cattle and range.

CALVES from the 212,000-acre range of the Isleta Indian Pueblo weighed an average of 255 pounds at shipping time in 1935. In 1938 the average weight was 378 pounds, an increase of 123 pounds.

Prior to 1934, the range was leased to non-Indian livestock interests. The Indians' annual income from it was $2,500 to $3,000. Under the present program the community herd is in position to return to the Indians an annual income of $7,000 to $9,000—triple the previous income.

Isleta Indian Pueblo lands are located 14 miles south of Albuquerque in central New Mexico. When these Indians leased the major portion of their range to non-Indian livestock interests, some 10,000 head of sheep and 1,000 head of cattle in the non-Indian herds usually grazed the area year long. In addition, 500 head of individually owned Indian cattle grazed there. This made a total of about 3,500 cattle units making use of these lands.

Due to the absence of adequate interior fences and range watering places, the distribution of the livestock was none too good. A range survey by the Soil Conservation Service, in the summer of 1935, revealed an estimated carrying capacity of 1,750 cattle units year long. Obviously, because of overstocking and poor distribution, the range was being utilized detrimentally. Land deterioration was apparent.

[1] Associate soil conservationist, Soil Conservation Service, Albuquerque, N. Mex.

The Isletas are not primarily livestock-minded, having become interested more in farming than livestock. The Office of Indian Affairs advanced the idea, early in 1934, of canceling leases to non-Indian grazers and, in lieu, encouraging the Indians to run livestock of their own.

In the fall of 1934 the leases were canceled and the non-Indian stock removed. Some 1,500 head of white-faced Hereford cattle, ranging from yearlings to old cows, and 85 white-faced Hereford registered bulls were obtained from the Federal emergency drought relief program for issuance to these Indians.

Early in 1936, this herd was culled to conform with the estimated carrying capacity established by the Soil Conservation Service survey. There remained 864 head of the best cows and 65 head of bulls, which were turned over to the Isletas and designated as the Isleta community herd.

An indenture was written by the Commissioner of Indian Affairs, providing for the management and payment of the herd by three Isleta trustees. One heifer yearling for each animal issued was to be paid to the Government by March of 1939. Enough steers were allowed to be disposed of annually through sales channels to provide funds for paying herders, and buying vaccines, salt and mineral supplement and other items incident to the management of the herd.

In accordance with the range management plan formulated as a result of the range survey, the range was subdivided into pastures by the use of interior fences. Corrals, and additional range watering places adequate for proper management, were added. One pasture of sufficient size was set aside for the individually owned Indian cattle, in which the majority are grazed. This class has remained fairly constant in number since 1934.

In January 1936, the administration of the range and cattle—the community herd and its allotted range in particular—was placed under the direction of a Soil Conservation Service range rider. The management from that time on has been exercised by the range rider collaborating with the trustees. Matters pertaining to the individually owned cattle also are handled by this group.

When issued, the community cattle consisted of a fair grade of the breed, while the individually owned

Representative Isleta-owned cattle. Range is in fair condition in immediate vicinity of water. Proper distribution and seasonal use have made it possible to show a remarkable recovery of the range in the neighborhood of permanent watering places.

cattle were of a rather poor quality, but of the white-faced Hereford strain. The latter cattle, prior to 1936, were sired mostly by grade bulls. A move was started, early in that year, to eliminate grade bulls and make available registered bulls from the community-owned bull herd.

The cattle industry among the Isletas has been very successful for the past 3 years. The entire community-owned herd presents a very outstanding picture. All of the females have been dehorned. There is a noticeable uniformity in color and body conformity. All are well located and acclimated. A noticeable improvement is seen in the quality of offspring in both groups of cattle as a result of mating with registered bulls.

Last November the trustees returned to the Government the final installment due on the community-owned cattle. The tally on March 1 of this year was 598 cows, 76 two-year-old heifers, 98 one-year-old heifers, 6 yearling steers, and 62 bulls—a total of 840 head. The maintenance fund had $10,322 in its account on this same date. At present-day market value, the cattle are worth approximately $41,000. This amount, plus the account in the bank, represents what has accrued to the Isletas as a result of the cattle program inaugurated in 1934. Lease accruals realized by these Indians from non-Indian livestock interests, prior to acquisition of the community cattle, amounted, annually, to $2,500 to $3,000.

A definite improvement is noted in the range vegetation since 1936. This is reflected in the weight of the calves at shipping time: 1935 calves weighed 255 pounds; 1936 calves, 265 pounds; 1937 calves, 335 pounds; 1938 calves, 378 pounds.

The success of the program is credited to the fact that the range has been stocked during the past 3 years at its estimated carrying capacity and the livestock have been managed properly. Close cooperation has prevailed between the trustees and the range rider. At no time has there been any difficulty in securing approval to the Soil Conservation Service plan of management. This task has been made easier by having to deal with only three individuals. Naturally in revolutionizing methods in range and livestock management, with a large group of individuals more difficulty is experienced in securing unanimity of opinion and action.

It would seem, therefore, that the Isletas have realized a very worth-while industry in having acquired livestock of their own in preference to leasing their range to others. The range resources are definitely better than in 1935 and a consistent improvement is taking place. The community cattle are now returning from $7,000 to $9,000 annually, compared to $2,500 to $3,000 from leases to non-Indians.

INCOME FROM PELTS

In Granite Canyon, Wyo., one rancher chalked up an income of $1,000 in 1937 from coyote, wildcat, skunk, weasel, muskrat, fox, and raccoon pelts taken from 3,759 acres and immediately adjacent territory.

ANOTHER LOOK AT THE CONTOUR BALK METHOD

By B. H. HENDRICKSON [1]

THE CONTOUR balk method as used in the Southeast refers to the practice of permitting certain winter legume cover crops, and sometimes winter grass-legume combinations, to go to seed in narrow strips or balks about a foot wide, between rows of summer crops. In order to provide space for cultivation, the minimum practical spacing for the rows of summer crops is about 4 feet.

Reseeding annual legumes are used, mainly crimson and southern spotted-leaf bur clovers. In the Piedmont, ryegrass seems to work well in combination, particularly with crimson clover. Hop and white clover, and the vetches, have been used also.

One of the basic ideas in connection with the use of the balk method has been to obtain volunteer stands of desirable winter cover crops, year after year, and during the summers to grow common row crops on the same land. Cotton, corn, cowpeas, soybeans, velvet beans, grain sorghums and a few other crops have been grown using this method. Another very valuable feature of the method is the protection against erosion afforded to sloping croplands. This protection is effectively provided by the dense-growing balk vegetation during the spring months when croplands ordinarily are freshly plowed and susceptible to serious washing. Another feature is the repeated green manuring and mulching.

The method has been used by a few southeastern farmers for a number of years, but has not found wide acceptance. It appears that there are several reasons why acceptance has not been more widespread: (1) On sloping croplands badly needing improvement and protection, it is difficult for most farmers to establish satisfactory stands of winter cover crops; (2) farmers fear that during wet springs, the balk vegetation will spread and smother out the young row crops or interfere with cultivation so that the cropland may become excessively weedy or grassy; and that during dry periods the competition for plant food and moisture will cause young stands of summer row crops to be set back, or to "burn up," and fail. Another point to be considered is that in some sections of the country, increased damage by insects may interfere seriously with the practice of growing certain combinations of crops in narrow alternate strips.

There is a chance that early spring rainfall may be inadequate, at times, to supply sufficient soil moisture for both the growing balk vegetation and the germination and seedling growth of summer row crops. Normally, the moisture needs of crops in seedling stages are so small that the localized use of soil moisture in isolated balk strips has not affected the early growth of row crops. In some years, reduced run-off should tend to offset this use of soil moisture. Of course, the alert farmer may plow out his balks at any time in the course of row-crop cultivation, if droughty weather demands that clean culture and dust-mulch surface soil conditions are more essential than standing balk protection and maturity of balk vegetation.

It is true that croplands planted to cover crops are not at first as easily turned as are fallow topsoils to which most Southern farmers are accustomed. In this connection, there is need for improvement in the design of plows and cultivators, particularly of single mule-drawn shovels, wings and sweeps ordinarily used as single-stock equipment.

Field tests of the method on the Southern Piedmont Experiment Station, in 1938 and 1939, have shown that winter cover crops of desired type for balk use can be grown on good to fair land, if proper preparation, some fertilization, and good inoculation and planting methods are used. Ryegrass has a rather wide adaptability and can be grown with crimson clover on the better land and with vetch on the poorer land. No tendency for weediness has been noted. In fact, the balk vegetation tends to smother spring weeds in balks which would otherwise need to be hoed out. Vetch is the only crop used which tends to spread. The third objection, namely, moisture competition between row crops and balk vegetation, is valid and serious, and appears to be the limiting factor in the use of the method. In two years of tests to date, however, no perceptible setback of young summer row crops has been noted, by comparison with growth in check areas which are clean tilled, up to the time that crimson clover matures its seed in late May. At that stage, early planted cotton is about 6 to 8 inches high. In fact, the young summer crops seem to do a little better in the interbalk rows than in check areas, during their early stages of growth.

Attempts are being made, in station tests, to determine whether or not it is possible to retain dense-growing balk protection for longer periods during the

[1] Project supervisor, Southern Piedmont Experiment Station, Athens, Ga.

growing season, without detriment to row-crop yields. Present indications are that this is inadvisable, unless some special layout is used. This is because June is a month of rapid vegetative growth for the principal row crops, and summer temperatures are likely to prevail so that evaporation and transpiration are likewise rapid. Clean cultivation is then highly important, in order to conserve all available moisture for use of crops.

Ryegrass is thought to be a desirable component in the balk vegetation mixture. It ripens its seed near the same time as does crimson clover and the two seeds can be combine-harvested together on seed patches. Ryegrass continues to grow, however, through June and does not die down until about the first of July. In balks it appears that this late ryegrass competition for soil moisture may be especially detrimental to row crops growing alongside, mostly so to corn and least so to cotton. In other words, ripening ryegrass does smother out weeds and delay the growth of crabgrass, but the conditions in June are such that clean culture is generally advisable; hence, the balks, it seems, should be plowed out about the first of June. Use of an earlier maturing grass would be preferable.

The resultant strips of mulch can be expected to be beneficial in various ways until the moisture and heat of summer bring about its decomposition. There was some indication, in 1938 tests, that crop response to the nitrogen cycle that accompanies this method may be favorable. Ordinarily, complete turning under of winter legume crops, in the spring, results in a peak production of nitrate nitrogen before summer crops can utilize it.

Station experience has been that early land preparation for summer row crops is desirable. Beds 4 feet apart leaving balks one foot wide may be prepared in February or March, for cotton. At that stage, only a small amount of green manure will have been turned under, but well-settled beds result, in which good germination can be expected. Box bedding for corn and sorghum appears best, with a team-drawn ripper to loosen the subsoil properly before the land is listed again to form a low bed. Beds may be cut down and settled with a team-drawn cutaway or disk harrow. Spring preparation by this method is faster than usual plow methods and more land can be handled, in early spring, with the same time and effort. In effect, part of the turning is done preceding the planting of summer crops, and part of it is delayed until about the third cotton cultivation, about June 1, when it serves both purposes.

From the standpoint of the soil conservationist, there are many points of interest in this balk method. For example, it seems to remove the risk attached to the growing of winter cover crops just ahead of cotton. When complete turning under is delayed in the spring in order to permit considerable top growth of green-manuring crops, there is danger that the necessarily early cotton planting date may be delayed and that poor stands may result. Another feature is that the same winter cover crops may be repeatedly grown as volunteering crops, for some years, on the same land with the likelihood that succeeding stands and growths will improve, as they generally do, as inoculation becomes better established. This applies to volunteering clovers which do not become diseased; it may not apply to the vetches. Still another feature is the flexibility of the cropping system, which is unique in that protective and soil-improving aspects remain, although summer crops may be changed.

In the event that original cover crop stands are thin, or that volunteering does not succeed in some years, it is a simple matter for a farmer to maintain his seed patch and gather his own unhulled seed for reseeding purposes in the fall, on land already well inoculated.

The southeastern farmers need to use better protective and soil-improving practices for their erosion-damaged lands. Any practical cropping plan, including protective and soil-improving features, which has elements of both permanence and flexibility, is desirable. It is true that the same winter cover crops used in the balk method can be entirely plowed under for green manure as part of land preparation for summer-grown feed crops, and the fields can be resown to the same or other winter cover crops in the following fall in order to obtain the better stands and growths that ordinarily recur after repeated plantings on well-inoculated, well-phosphated cropland. The balk method, however, achieves the same end more economically and at the same time apparently does not limit the summer crops to late planted or catch-crop types.

Summarizing, the balk method provides for yearly volunteer stands of winter cover crops; it permits temporary field grazing in early spring; it provides green manure plowed under early, each year, together with contour strips of mulch to produce more slowly decomposable organic matter; and it makes possible the production of a choice of summer row crops each year. From the point of view of protection, it appears that the best available winter cover is supplied, with

(Continued on p. 40)

IT WAS UTAH'S "DUST BOWL"

By FRANK J. HALE [1]

A FEW WEEKS ago I talked with Wallace Sagers, the first cowboy and sheepherder in the Tooele Valley, 20 miles west of Salt Lake City, whose keen memory enabled him to go back to the early days as vividly as though it were but a year ago.

Seventy years ago, when Mr. Sagers was 10 years old, it was his job to look after the cattle and sheep in the Tooele Valley. All stock were put into a cooperative herd. His first band consisted of 10,000 sheep and 7,000 cattle.

"It was not much of a job in those days looking after just that many," Sagers told me. "About all I had to do was see that they did not feed too high up in the mountains. That was not hard, as wild flowers and sweet grasses were above the sheep's backs and up to the cows' bellies. Naturally, stock moved about at different seasons, taking the lower country towards the lake shore in the winter and reaching the higher land in the summer, but not into the forest."

"But why," I asked, "did you not want them to get into the mountains? Nowadays the forest reserves are considered our best ranges."

"Yes, *now*. But we thought it mighty poor feed then, compared with our valley."

Mr. Sagers said he stayed on the herding job 8 years. Only once did the farmers do any winter feeding; they hauled out some hay and beets during a very severe winter.

TOOELE VALLEY was first settled about 1847 when a few hardy pioneers pushed their way west from Salt Lake City. As they rounded the north end of a rugged mountain 20 miles from Salt Lake City, a beautiful valley opened up before their eyes. It must have been a paradise to them at that time.

Some 20 miles farther west was a high, beautiful, snow-capped range. To the south about 15 miles was a low cedar-covered mountain. The mountain they had just rounded, running south, was rugged and picturesque as the one to the west. Completing the boundary, the briny waves of the Great Salt Lake lapped lazily against sandy shores on the north.

As the pioneers moved forward through deep luscious grass, herds of nimble antelope frolicked at a safe distance. Every hour they traveled brought new proof of what a real haven they had found. Streams of pure cold water, fed from the high east and west ranges, flowed lazily into a deep fertile valley.

This dust-hazard sign was removed 3 years after establishment of the Grantsville demonstration area. Dust storms formerly brought traffic to a standstill on the main transcontinental highway between Salt Lake City and San Francisco.

It was not long until homes were built along these streams. Winter feed for their horses and oxen was cut from almost any part of the valley the pioneers decided was handiest.

Those pioneers had come a long way to find a home and peace and contentment. There was no craving for power or wealth. And Mr. Sagers goes on to tell the story of the land:

"Perhaps I will never know just why we sons and grandsons did not follow in the footsteps of our wiser forefathers. I do know that we wanted more than the pioneers wanted. We thought running large herds of sheep and cattle was our shortest route to wealth. We gave little thought to the future.

"More and more livestock were turned into these grassy ranges. Twice a year large outside trail herds tramped across the valley, lingering as long as possible to pick up any available feed. Slowly the grass disappeared and sage took its place. Overgrazing stunted and scattered the sage until what was once a range of plenty became almost barren.

"From time to time, hot, destructive brush fires swept through the valley, destroying what little perennial vegatation was left. Ever anxious to increase our income, we plowed up many acres that without irrigation could not yield crops on our less than 12 inches of annual rainfall. The wind whipped up small dust clouds, sending them into the city. Still there was no let-up in the heavy grazing and trampling. Then, to top off man's abuse of the land, there came a drought.

[1] Board of supervisors, Grantsville soil conservation district, Grantsville, Utah.

"In 1934, almost all sign of vegetation was gone. Even ground squirrels and jackrabbits were forced to hunt other range. When the wind blew, it was not just little puffs of dust that rolled by. We went through misery. We ate sand and dust.

"Suffering from the catastrophe was not confined to the 1,200 citizens of Grantsville. Only a few miles away, 5,000-peopled Tooele, and the farming communities of Erda, Lake View, and Lake Point also breathed the dust. Soil from Tooele Valley settled as far away as Salt Lake City, Ogden, and Logan. Idaho got some of Utah's dust.

"You no doubt have seen heavy cloudbursts or snowstorms roll down, darkening the country about you. The dust was ten times worse. Instead of rain or snow, a thick hot dust whirled into our faces as we ran choking for protection. But our houses did not protect us much, for the fine powdery dust knew no barrier. It came through the key holes, window sills, and door frames. Although we tried to plug every possible opening, within a few hours our houses and everything in them had a thin layer of powdery dust.

"One day I got so restless I climbed into my car, turned the lights on, and drove slowly through the whirling dust to the post office.

" 'We ought to give this country back to the Indians,' I told the postmaster.

" 'Humph,' grunted an old Goshute buck. 'Indians no want them. White man spoil them.'

"And so it was; even the Indians did not want what was once a paradise, nor did most of us want it. Penniless and disheartened, we began to look for some place to go, some place else to build another home. Our formerly luxuriantly grassed valley was now barren; it was the Utah Dust Bowl, to put it mildly.

"Then, in 1935, the United States Soil Conservation Service helped us to work out a land-use program to get vegetation back and stop the dust blows, and make the valley productive again.

"The land that the dust was coming from was put under cooperative agreement—in all, 32,000 acres.

The air is much clearer now, in the Grantsville demonstration area. Soil conservation practices in 2 years have brought back a fine cover of perennial ricegrass, sandgrass, needlegrass, and wheatgrass.

Later, in 1938, we organized a soil conservation district under the State law.

"Every method that was practical, and the cost reasonable, was used to get a covering of vegetation on this area. Livestock were removed, and men worked to regain these lands. Early in the spring of 1936, seeds of hardy vegetation were planted. A sturdy fence was put around the project. Dams were built to keep the spring rains from rushing madly away. On the slopes, contour furrows were plowed to hold back the water.

"Fire lanes were made and fire protection diligently practiced. Soon the land began to show signs of life again, and in 1937 only little puffs of dust were to be seen.

"In 1938, the wind blew hard, but the air was clean and fresh. On January 1, 1939, under strict supervision of the Grantsville soil conservation district board, several thousand head of sheep, horses, and cattle were allowed to enter the area for 2 months. The Soil Conservation Service gave technical advice.

"Perhaps next year we may allow more stock and a longer grazing period. There is no doubt in my mind that before long stockmen will get more winter feed from this area than they have in many years past.

"In 1938 when the soil conservation district was formed, a board of five local supervisors began to manage the conservation and land-use program for the landowners. The Soil Conservation Service continued to help the conservation program along through the board of supervisors of the district.

"Now the dust is settled and the grass and feed are high and luscious again, and the local soil conservation district is working hard with the Service technicians. We supervisors are bound to be criticized by stockmen in the district for our conservative plans to see that this area never goes back into a dust bowl.

"We, the local committee, were elected by the people within the dust area. We serve without pay or expense money, but our whole heart is in our job. We want to keep this valley a place that our children and our children's children will be proud to call home.

"In my wanderings over the Western States, I see many places that are slowly but surely being tramped and grazed into dust beds; many sheep grazing on arid lands where only half as many should be; large herds of cattle killing feed within miles of the few desert water holes; sheepmen keeping their herds too long on each bed ground.

"And all for what?

"Along with the Soil Conservation Service, we citizens of Grantsville earnestly hope that our sufferings have been to some avail. We appeal to other Americans to heed the lesson we have learned. The key to soil conservation lies not in cure, but in prevention. Proper land use, if begun in time, can prevent destructive, demoralizing dust storms and serious floods, and will yield a thousandfold in sustained income through conservation of the fertile topsoil. Only minerals should be mined—don't try to mine our soil and plants."

ANOTHER LOOK AT BALK METHOD

(*Continued from p. 37*)

strip protection at close spacings during the spring, followed by some mulching during the summer. In the fall, repetition of the cycle begins. The best balk vegetation so far tested at the Southern Piedmont Experiment Station is the crimson clover-ryegrass combination. On *average cropland* it seems to require a successive seeding for proper establishment. On *good land*, on a Georgia farm, it has been volunteering for at least 10 years in this method. Unquestionably, the soils have been improved; the sloping lands have been protected to a considerable degree, and summer crop yields are said to have increased gradually during the period.

Most southern Piedmont cropland soils are in more or less eroded and depleted condition, due to long continued soil-exhausting clean culture. Hence, it is likely that the repeated use of cover crops, as is possible in the balk method, will gradually bring about better granulation or mellowing of plowland, because of organic accumulation, and will eventually also increase productivity.

It is going to require several years of experimentation to determine the effects of this method upon soils and crop yields. As yet, no quantitative data have been obtained relative to soil and water conservation. Observations made during and after erosive rains indicate that substantial protection is afforded, along with reduced run-off, particularly in the spring months.

WESTERN RANCHES AND WILDLIFE

On less than 20,000 acres of private and State land a ranch near Alamogordo, N. Mex., received $2,800 in 1938, and $4,000 in 1937, for mule deer hunting privileges at $100 per hunter per season. The hunter's fee entitled him to lodging, food, saddle horse, and guide.

In New Mexico a rancher receives $45 a year for duck-shooting privileges on a single pond with a water surface of about 1 acre.

Contour sod buffer strips at the Boys' Industrial School farm, Lancaster, Ohio.

THE STATE COOPERATES

By HAL JENKINS [1]

AN OUTSTANDING EXAMPLE of State cooperation in a land-use program is to be found in Ohio, where the department of welfare has joined forces with the Soil Conservation Service in conserving the soil resources of 21,000 acres of publicly owned farm land.

The program now underway is of particular value as a demonstration because Ohio's welfare institutions are so located that they represent practically every important erosion problem area in the State. And practices on State-owned farms are closely observed by private farmers.

John D. Bragg, chief agriculturist for the welfare department, and D. T. Herrman, State coordinator for the Service, started the ball rolling during 1938.

AS A PRELIMINARY step, a 2-day school for the institutions' farmers and gardeners was held in March 1938, at the erosion experiment station and on the project area of the Service near Zanesville. A similar school was held in March this year at the Apple Creek State Hospital farm, Wayne County. Technicians of the Extension Service and the Soil Conservation Service conducted the school.

To date Mr. Bragg and his farmers and gardeners, assisted by technicians of the Service, have made complete erosion control plans for the State farms at the Apple Creek, Massillon, and Mount Vernon State institutions. Plans are being prepared for the institution farms at Athens, Dayton, Delaware, Lancaster, Lebanon, Lima, London, Macedonia, Mansfield, Marysville, Orient, and Sandusky. As rapidly as possible plans will be completed for all the State farms which have erosion problems.

Mr. Bragg takes a long-range view of the problems of State institution farms. "We realize," he points out, "that it is our job to produce as much foodstuff as possible to enable these institutions to be at least partly self-sustaining; but we also recognize that it is equally important for us to conserve and improve our soil resources because the same need will exist 100 years from now."

A like attitude on the part of the managing officers and agricultural department heads has enabled the welfare institution farms to make unusually rapid progress in the adoption of soil-conservation measures during the past year and a half.

[1] Section of information, Soil Conservation Service, Dayton, Ohio.

EROSION CONTROL REDUCES SEDIMENTATION

STREAMS flowing into the municipal reservoir on Deep River, 4 miles northeast of High Point, N. C., carry 50 percent less sediment today than in 1934. This information was obtained in a recent survey conducted by the Service during a period when rainfall was above normal. Furthermore, cost of filtering water has been decreased, and the life of the reservoir has been extended several years.

In 1934 the Soil Conservation Service, in cooperation with the United States Geological Survey, found that sediment was reducing the storage capacity almost 1 percent a year. The amount of soil accumulating in the reservoir represented a loss of more than a ton of topsoil from each acre of land in the 40,000-acre watershed.

In the summer of that year farmers in the watershed area cooperated with the Service in working out erosion-control programs. Today more than 40 percent of the farmers, occupying most of the land in the watershed area, are working with the Service on a conservation program which includes contour cultivation, terracing, crop rotation, and vegetative control.

It is to these 5 years of conservation practices that technicians of the Service attribute the reduction in loads of silt, soil, and debris carried into the million-dollar lake by tributary streams.

WIND EROSION DAMAGE CHECKED IN NAVAJO LAND

By J. NIXON HADLEY and DAVID ROGERS [1]

KAYENTA, ARIZ., whose post office is farther from a railroad than any other in the United States, has turned out to be the setting for the story of one of the Service's most successful fights against the ravages of wind erosion.

Kayenta lies in the remote, isolated interior of the 16-million acre Navajo Reservation, in northeastern Arizona not far from the southern boundary of Utah.

Here the Navajo Indians graze their sheep and goats and raise little patches of corn and squash. Those Navajos who farm depend on irrigation water from a reservoir which is filled by autumn run-off in nearby Laguna Creek.

OVERGRAZING had left the sandy range practically denuded. There was little grass for soil protection or for forage. Wind, blowing over this bare ground was rapidly turning the area into a series of sand dunes, ruining the farm land and endangering the settlement of Kayenta because of sand movement.

Irrigation ditches from Laguna Creek to the reservoir and from the reservoir to the fields play a large part in this story because year after year they filled as fast as the Navajo farmers could clean them out.

Figures confirm this. In the fall of 1936, 180 workdays by men with teams and 160 workdays by men without teams were required to clean the ditch leading to the reservoir—almost a year of workdays.

The following spring, 380 man-team days and 380 man days—over 2 years of workdays—were needed to clean the ditch from the reservoir to the fields.

ALL IN ALL, the Navajos were about to give up on the ditch cleaning job, which seemed a hopeless waste of work, and abandon the farming area. This would have meant a serious loss to them. Farm land is scarce in the Kayenta country, and the loss of this acreage probably could not have been made up by replacement elsewhere.

But here the picture begins to change for the better.

In the fall of 1937, the area surrounding the ditch was added to the Kayenta demonstration area which had been set up by the Soil Conservation Service in the early days of its operations in the Navajo country.

As part of the soil-erosion-control program, the stock on the adjacent range was reduced to the proper carrying capacity. Sand fences of wire and brush were built to break the wind and check the shifting sand dunes. Large dunes are being stabilized by grass plantings. Trees were planted in critical areas between the dunes to stop, eventually, the force of the wind. Blow holes were crisscrossed with furrows and planted.

And then the ditch job changed.

Results of the erosion-control program showed up as early as the following spring. In the spring of 1938, when the Navajos cleaned the ditch, 380 man-days and only 110 man-team days were needed. This was

[1] Assistant soil conservationist and associate agronomist, respectively, Soil Conservation Service, Gallup, N. Mex.

a saving of two-thirds of the man-team labor with an increase of one-third of the man-days without help of teams—altogether a marked decrease in the total amount of work.

But still more gratifying are the workday figures for the fall cleaning job in 1938. Thirteen days' work by men without teams served to clean the ditch, remove weeds, sand and silt. The saving in labor over 1936 was 180 teamster days and 157 man-days.

The Navajo farmers, in 1936, felt that any amount of work on the ditch was well-nigh useless. Last fall the small amount of labor required was done cheerfully and hopefully, because they felt that the ditch work was not wasted and that they would have an adequate supply of water with which to irrigate their crops.

Thus, a single year's program of range control, together with a few simple structures, put a formerly denuded area well on its way back to recovery. Grass annuals and browse plants are growing; dunes are nearly stabilized; and the irrigation ditches are no longer choked with drifting sand. In addition, the demonstration has changed the attitude of the Navajos of the area from active antagonism to one of accordance with the Soil Conservation Service program.

CHOOSE SUPERIOR LOCUST STANDS

(Continued from p. 32)

production purposes. The identity of stock is, of course, maintained through the production period in the nursery and finally in the field.

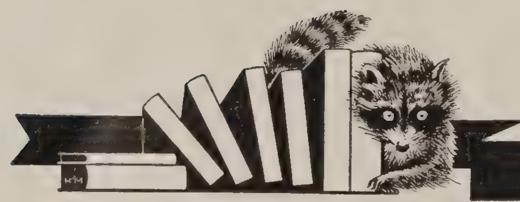
In the vicinity of Hartsville, Ind., is located a stand of locust known as the Higby Grove, which, according to results obtained by Dr. Ralph P. Hall of the Division of Forest Tree Insects, Bureau of Plant Industry, exhibits not only desirable growth characteristics but also appears partially resistant to attacks of the locust borer (*Cyllene robiniae*). Other desirable stands are located in the vicinities of Howell, Mich., New Castle, Ind., and Alma and Zanesville, Ohio.

However important other duties may appear to be, time spent in locating good stands for seed collection will be time well spent.

PATTERN FAVORABLE TO WILDLIFE

If the pattern of agriculture—using the term in its broadest sense—as developed on this major portion of the land is favorable to wildlife, then wildlife will be abundant. If the pattern is unfavorable, or only fair, then we shall have wildlife in proportion.

Contour tillage is fundamental to a sound program.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

NATIVE LEGUMINOUS PLANTS OF WISCONSIN. By Norman C. Fassett. University of Wisconsin Press. Madison, 1939.

Here is a book that supplies a long-felt want for an adequate source of material for the identification of legumes. A good key for leguminous plants has been needed for a long time by field men of the Soil Conservation Service; those without library facilities have been unable to identify many of the legumes. According to Dr. Dahl, Section of Agronomy, the keys presented in "Native Leguminous Plants of Wisconsin" should prove very valuable to field men of our Service.

The volume is the result of several years of extremely careful study on the taxonomy, ecology, and distribution over North America of the Leguminosae now growing in Wisconsin without cultivation. It is richly illustrated, with drawings by Dr. R. I. Evans, and photographs made with special camera devices for the outside views and detailed views of living plants and herbarium specimens. Of the many maps showing distribution of the species the author states that "every dot * * * is based on a specimen actually examined by the writer, with the exception of a few species in the Deam herbarium." The final section of the volume, prepared by Catherine Mose, is on the special subject, epidermal outgrowths of the Leguminosae of Wisconsin.

The distribution and migration information makes the book more or less unique and especially useful to the student or the field man working with leguminous plants. Wisconsin is apparently on the margin of the range of the Leguminosae in this country—only five of them were found ranging throughout the State. A large block of southeastern woodland species, about 18 of them, reach their northwestern limit in Wisconsin. A few southern species appear to have invaded the State via the Mississippi River. Several prairie species reach their northeastern limit in Wisconsin, and a few which are usually confined to marine beaches are found on the shores of Lake Michigan and Lake Superior.

The book contains five keys to the Leguminosae, the first of which is an artificial key based on the vegetative characters. It contains about 100 species and is very easily followed. The second and third keys are based on flowers and fruits respectively and carry the plants through to the characters of the genera of which there are about 25. The fourth key is based on seeds. It contains about 35 species and genera. Some of the genera are not divided into species. A fifth key is based on the characters of the epidermal outgrowths.

Brief descriptions of many of the genera and species are given; and their distribution throughout the country, and more particularly throughout the State of Wisconsin, is discussed with special reference to migrational routes and present local habitats. Detailed keys of many of the genera are also included.

The scope of the volume is limited, of course, to the legumes which have been found in Wisconsin, and therefore many of the important and common southern species and several that are found in the East are omitted; enough species are included, however, so that anyone who is interested in the identification of plants will want a copy for his library.

HANDBOOK OF FERTILIZERS, 3d edition. By A. F. Gustafson. New York, 1939.

This concise volume is now brought up to date for the convenience of field men and farmers. It presents authoritative information on the sources, effects, make-up, and uses of the known fourteen elements required for the growth of plants. The author tells first why these elements are necessary to plant nutrition and then follows up with three detailed chapters on the sources and availability of nitrogenous, phosphatic, and potash fertilizer materials. The organic, synthetic, and inorganic ammoniates receive considerable treatment, and a table is used to show the plant-nutrient content of all of these nitrogen-carrying materials. A chapter giving the effects of fertilizers upon various crops and soils is brief but most concise and easily comprehensible. The second half of the book is devoted to the make-up and mixing of fertilizers, and public control of sale and analysis of commercial products used as plant nutrients. The New York fertilizer and lime law is discussed as an example of public demand for accurate analysis and effective mixing to minimize deficiencies. Home mixing of fertilizers is discussed as to advantages and disadvantages. Convenient tables are given to show the availability of materials, how to attain uniformity in mixtures, composition of materials, weights required to supply a unit of plant nutrients, make-up, quantities of material required, and suggestive formulas for home mixing.

Dr. Gustafson gives many helpful suggestions for the purchase and use of fertilizers for various crops and soils and for methods of application. He devotes a special chapter to the subject of liming in relation to the fertilizer practice. Finally, soil organic matter is discussed briefly, and here is found handy information concerning the addition of lime and phosphorus, the use of crop residues and barnyard manures, crop rotations, and green manures. An index is included for convenient reference.

North Dakota Windbreak

Since 1936, Bert Phair, Soil Conservation Service cooperator, 5 miles southeast of Park River, N. Dak., has planted 30 acres of his farm land to trees and shrubs for protection against wind erosion. He estimates that these plantings have increased the value of his farm $1,000 to $1,500.

His main windbreak, about 2½ years old, runs a mile along the north and west sides of that part of his cultivated land which receives the hardest winds. At the end of the 1938 growing season, the center two rows of cottonwood trees averaged 15 to 18 feet in height. Representatives of the Service say that these trees are among the largest found on cooperating farms in the four-State region of the Dakotas, Montana, and Wyoming. Border rows of green ash, Russian olive, box elder, and other adapted species were later planted in 1937, and finished the growing season with good growth and height. They were dwarfed only by the towering cottonwoods. "This past year," Mr. Phair said, "there was no blowing at all for some distance out from the trees. We judged that it was 5 to 10 rods before the wind took hold at all."

U. S. GOVERNMENT PRINTING OFFICE: 1939

New Technical Publications Throw Light on How to Conserve the Land

For REFERENCE

Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field Offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Black Lands Experimental Watershed Ground Water Graphs. 1936-37. SCS-TP-24. May 1939. mm.[1]

The Flow of Water in the Main Diversion Floodway of the Little River Drainage District in Southeast Missouri. (Article prepared by C. E. Ramser in 1924 while he was with Bureau of Public Roads.) SCS-TP-22. April 1939. mm.[1]

Legumes: Their Erosion-Control and Wildlife Values. SCS-TP-23. June 1939. mm.[1]

North Appalachian Experimental Watershed Ground Water Graphs. 1936-37. SCS-TP-21. January 1939. mm.[1]

Office of Information United States Department of Agriculture

Effect of Intensity and Frequency of Clipping on Density and Yield of Black Grama and Tobosa Grass. Technical Bulletin 681. Forest Service. May 1939.

Erosion and Related Land Use Conditions on the Muskingum River Watershed, Ohio. Soil Conservation Service. March 1939.[2]

Flow of Water in Irrigation and Similar Canals. Technical Bulletin 652. Bureau of Agricultural Engineering. February 1939.

Grasshoppers and Their Control. Farmers' Bulletin 1828. Bureau of Entomology and Plant Quarantine. June 1939.

Growing Wheat in the Eastern United States. Farmers' Bulletin 1817. Bureau of Plant Industry. May 1939.

Insect Enemies of Western Forests. Miscellaneous Publication 273. Bureau of Entomology and Plant Quarantine. Slightly Revised April 1939.

Planning for a Permanent Agriculture (Including a Summary of the Programs Administered by the Department of Agriculture that Influence the Use of the Land). Miscellaneous Publication 351. June 1939.

Plantation Organization and Operation in the Yazoo-Mississippi Delta Area. Technical Bulletin 682. Bureau of Agricultural Economics. May 1939.

Strawberry Clover. Leaflet 176. Bureau of Plant Industry. July 1939.

Subsoil Moisture under Semiarid Conditions. Technical Bulletin 637. Bureau of Plant Industry. April 1939.

Sweetclover in Corn Belt Farming. Farmers' Bulletin 1653. Bureau of Agricultural Economics and Bureau of Plant Industry. Revised May 1939.

Terrace Outlets and Farm Drainageways. Farmers' Bulletin 1814. Soil Conservation Service. July 1939.

Agricultural Experiment Stations

Composition of Common California Foothill Plants as a Factor in Range Management. Bulletin 627. California Agricultural Experiment Station, Berkeley, Calif. March 1939.

Crop Rotation Studies. Bulletin 227. Idaho Agricultural Experiment Station, Moscow, Idaho. December 1938.

Early Cut Artificially Dried Hays for Dairy Cows. Bulletin 446. Vermont Agricultural Experiment Station, Burlington, Vt. April 1939.

Effects of Fertilizer Applications and Other Cultural Practices on Some Kernel Characteristics of Winter Wheat. Bulletin 432. Purdue University Agricultural Experiment Station, Lafayette, Ind. October 1938.

The Effect of 1936 Flood Deposits on Vermont Farm Lands. Vermont Agricultural Experiment Station, Burlington, Vt. Bulletin 445. March 1939.

[1] Issued for use by Soil Conservation Service staff and cooperating officials only.
[2] Free distribution restricted to Federal offices and agricultural workers in the surveyed area.

Farm Adjustments in Montana. Study of Area VII: Its Past, Present, and Future. Bulletin 367. Montana Agricultural Experiment Station, Bozeman, Mont., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture with the assistance of Works Progress Administration. March 1939.

Farm Drainage: Its Maintenance and Construction. Circular 493. Illinois Agricultural Experiment Station, Urbana, Ill. April 1939.

Grasses of the Hawaiian Ranges. Bulletin 82. Hawaii Agricultural Experiment Station, Honolulu, T. H. May 1939.

Improving Beef Cattle Pastures on Rice Lands. Louisiana Bulletin 305. Louisiana Agricultural Experiment Station, University, La. March 1939.

Leguminous Plants and Their Associated Organisms. Memoir 221. Cornell University Agricultural Experiment Station, Ithaca, N. Y. March 1939.

Maintaining Soil Fertility in South Jersey. Circular 383. New Jersey Agricultural Experiment Station, New Brunswick, N. J. February 1939.

Managing Farm Flock Sheep for Greater Profit in Southern Idaho. Bulletin 228. Idaho Agricultural Experiment Station, Moscow, Idaho. March 1939.

Methods and Machinery for Harvesting Soybeans. Bulletin 319 Virginia Agricultural Experiment Station, Blacksburg, Va. February 1939.

Neutralization Curves for the Humic Acids of Peat Soils. Memoir 219. Cornell University Agricultural Experiment Station, Ithaca, N. Y. February 1939.

Rapid Soil Tests for Estimating the Fertility Needs of Missouri Soils. Bulletin 404. Missouri Agricultural Experiment Station, Columbia, Mo. April 1939.

The Relationship of Stream Flow to Precipitation on the Salt River Watershed Above Roosevelt Dam. Technical Bulletin 76. Arizona Agricultural Experiment Station, Tucson, Ariz. July 1938. mm.

Social Conditions in the Delta Area, Utah. Bulletin 288. Utah Agricultural Experiment Station, Logan, Utah. June 1939.

State Reforestation in Two New York Counties.—The story of the land and the people. Bulletin 712. Cornell University Agricultural Experiment Station, Ithaca, N. Y. February 1939.

Studies on Raritan River Pollution: II. Bulletin 659. New Jersey Agricultural Experiment Station, New Brunswick, N. J. April 1939.

What's New in Farm Science. (Part II, fifty-fifth annual report for year ended June 1938.) Wisconsin Agricultural Experiment Station, Madison, Wis. Bulletin 443. March 1939.

Miscellaneous

Analysis of Interregional Competition in Agriculture. Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C. April 1939. mm.

Farm Business Survey on 72 Farms Located in Leroy Soil Conservation Service Project Area, McLean County, Illinois, for the Year 1938. Illinois Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. May 1939. mm.

The Farm Forest. Extension Service Leaflet 147. Massachusetts State College, Amherst, Mass. Revised October 1938.

Fundamentals of River and Canal Hydraulics. Price Rs. 2. Northern India Printing & Publishing Co., Lahore, India.

Land Use in New York. Bulletin 406. Extension Service, Cornell University, Ithaca, N. Y. April 1939.

The Management of Farm Woodlands in New Hampshire. Extension Bulletin 55. University of New Hampshire, Durham, N. H. December 1938.

A Pasture Program for Tennessee Farms. Publication 217. Extension Service, University of Tennessee, Knoxville, Tenn. January 1939.


S.C.S. DISTRICTS
WATER FACILITIES
LAND UTILIZATION
ENTERING
DEMONSTRATION
PROJECT
SOIL CONSERVATION
SERVICE
U.S. DEPT. OF AGRICULTURE
C. C. C.
and
FLOOD CONTROL

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

This issue offers late information on what is being done to put farms and ranches under a vegetative cover. See page 47 for a summary of the accomplishments of the Soil Conservation Service in regrassing.

SEPTEMBER

1939

Contents

Front cover by Adrian Clem
Back cover by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 3 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON SEPT. • 1939

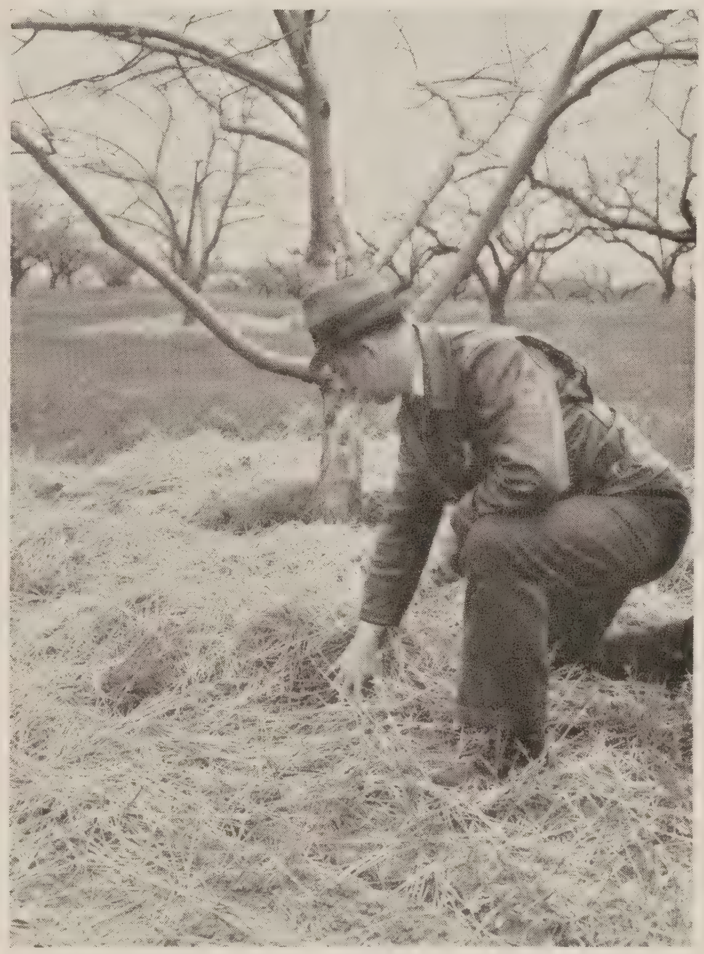
MULCHING NORTHEASTERN ORCHARDS

By GROVER F. BROWN[1]

AFTER the cyclonic winds and gully-gouging rains of last year's Atlantic hurricane, many New England orchardists learned the value of mulching under their trees. The practice was recommended by research and extension workers to help in reestablishing damaged root systems of partially uprooted trees that were pulled back and reset. It proved particularly valuable in conserving rain for use by the extremely weakened tree roots and also eliminated competition of weeds for moisture and food nutrients. The protective mulch covering especially benefited trees on heavy soil with poor aeration.

In New England, as in most of the Northeast, there are farm orchards in almost every farming section, but commercial producing units are confined to a relatively few States where no such catastrophic measure as a hurricane is necessary to impress upon the minds of growers that mulching is one of the fundamentals of soil management in productive orchards.

The use of mulch is not new. It can be traced back almost to the beginning of commercial production of certain crops. Its use in orchard soil management, however, is probably confined to the last 40 years. Three outstanding pioneers in orchard mulching were F. T. Bergon, of Delaware County, Ohio; Grant Hitchings, of Syracuse, N. Y.; and A. E. Janson, of New Platz, N. Y. Mr. Janson lays claim to the oldest McIntosh block in the Hudson River Valley; on it he has practiced mulching for the last 25 or 30 years. For the last 20 or 25 years he has applied no mineral fertilizer of any kind, yet his average yield has been from



Dr. Brown inspecting straw mulch under apple trees in a mixed planting of peaches and apples near Hancock, Md.

20 to 30 bushels per tree. The Ohio Experiment Station was also among the first to seek definite information relative to the practice and economic use of mulching in orchard soil management.

The term "mulch" has a variety of meanings. For the purpose of this discussion, it is considered as any material placed under orchard trees in sufficient quantity practically to eliminate growth of grass or weeds. There are about six modifications of the mulch system of soil management which fit this general definition.

[1] Chief, regional agronomy division, Northeastern Region, Soil Conservation Service, Upper Darby, Pa.

171505—39——1

For instance, there may be mulch to the periphery of the trees with sod in the middles; mulch under the trees with the middles clean-cultivated; mulch under the trees with the middles following a cover-crop system; mulch with inter-crops in the middles; mulch with no attention given to the middles; and, mulching of the entire orchard to prohibit weed growth.

One of the primary functions of mulch is its control of soil erosion. In view of the scarcity of desirable orchard soils and sites, this is highly important, not only from the standpoint of the life of an individual block, but for the continued production of profitable blocks on the particular site.

Aeration of the surface soil is improved under a mulch system of soil management; there is better biological activity with a consequent beneficial effect upon soil fertility. Soil structure has been markedly affected under mulch. For instance, a covering of mulch does not permit compaction of the surface soil often resulting from a hard rain; it does permit rapid penetration of moisture. It is in fact a greater factor in moisture penetration than any other, including soil type itself.

The conservation of moisture and its subsequent utilization by the tree is of fundamental importance to the grower on any good orchard site. As shown by the Ohio Experiment Station,[2] the moisture absorption under mulch was 30 percent faster than under corresponding sod, and 60 percent faster than under a cultivated system immediately adjacent to the mulch. Along this line, observation in mulched orchards shows a definite development of roots immediately under the mulch. In most instances, these are all feeder roots, which will develop under mulch wherever conditions are favorable. Gourley,[3] at the Ohio station, traced relatively large roots, near the surface of the ground, until they came to the edge of the mulch where they immediately turned downward, in search of more favorable conditions. This indicates that the placement of the mulch should be well beyond the drip of the branches to widen as much as possible the feeding zone of the roots, so that the tree may be supplied with optimum amounts of moisture and food nutrients. In view of the fact that under mulch the fibrous roots increase in number near the surface of the ground, it is logical to believe that such roots will be in a position to make the maximum use of light thunder showers, which are insufficient to wet the soil to a depth that would be beneficial to roots farther down in the soil. This may be of particular importance in dry years, when rainfall is in the form of light summer showers.

Practically every investigator reports modifications of soil temperature under a mulch system. Where winters are severe, a mulch layer may be of extreme importance in preventing frost penetration to a depth sufficient to cause permanent injury to the tree. In summer, there appears to be a definite leveling off of extremes in temperature variations, and this, naturally, is conducive to bacterial activity and nitrate development. As a matter of fact, it has been found that nitrate development becomes more uniform throughout the entire growing season under mulch than under cultivation.

Various kinds of mulching materials have been used on practically every type of fruit grown in the Northeast. Perhaps the straw of small grains leads the list. However, pea vines, bean vines, spoiled hay of various kinds, saltgrass hay, cornstalks, manure and, in fact, any type of material that can be cut and hauled to the trees, has been used.

Many growers have found that mulch is very advantageous for apple varieties, such as McIntosh, Williams, Wealthy, etc., that have a tendency to drop. By placing a heavy mulch under the tree, these drops may be gathered with practically no loss in total production. In fact, some of the growers even take mulch from beneath early maturing trees, after they have been picked, and place it under later maturing varieties, to catch their drops.

A number of reports have been made relative to the increased mineral nutrients under a sod system of orchard soil management, Wander and Gourley[4] found that the potash content under mulch amounted to approximately 1,000 pounds per acre, while trees under cultivation only 40 feet away showed approximately 175 pounds per acre at the same depth. Furthermore, there was approximately twice the amount of organic matter in soil under mulch as under clean cultivation.

In Massachusetts,[5] observation showed very definite increases in growth and bud formation of trees with the mulch system of orchard soil management. This increased growth and bud formation produced increases in leaf production, and, of course, increases in fruit production. This is a matter of primary importance to the commercial grower, as his margin of profit is often determined by a slight increase in yield per tree.

[2] F. H. Beach: Apple Production Under the Mulch System. Annual Report of the State Horticultural Society of Michigan, 1937.

[3] Reported in the paper cited in footnote 2.

[4] I. W. Wander and J. H. Gourley: The Potassium Content of Soil Beneath a Straw Mulch. Science, December 10, 1937.

[5] J. K. Shaw and L. Southwick: Heavy Mulching in Bearing Apple Orchards. Bulletin 328, Massachusetts Agricultural Experiment Station. March 1936.

Mulch has been found to stabilize yields, especially in years when weather conditions are quite unfavorable. This is of particular importance, because widespread unfavorable weather conditions are reflected in a higher price to those few producers who have good crops to sell. There is some evidence to indicate that increased terminal growth and leaf may be effective in establishing the production in "off" years of some varieties of apples. A small increase in size of each fruit means a very considerable increased total yield and a decrease in the number of small or culled fruit.

On an individual farm mulch may be produced on land that is not suitable for orchards. The purchase price of straw or spoiled hay, delivered to the orchard, varies; often it is one of the primary factors prohibiting wider application of the mulching practice, since the initial application is expensive. This often necessitates the mulching of part of the orchard each year, until the entire orchard is finally covered. It usually requires from one to three tons per acre, annually, to maintain a mulch of sufficient depth and density to prevent weed and grass growth. Many growers, however, could produce a great deal more mulching material in the tree middles, especially in young orchards, if they would give proper attention to line and fertilizer practices similar to those used by general farmers in the production of high yields of hay.

Increased possibility of mouse damage, fire hazard, increase in certain insects which may be benefited by the ground cover and the possibility of too great a supply of nitrate late in the season, which might result in immature wood and possible winter injury, are some of the common objections to the use of mulch. Mice may be adequately controlled by following a definite poisoning campaign and protecting the tree trunks by eliminating any mulching materials within a radius of 3 or 4 feet from the trunk. Fire hazard is greatest when mulch is first applied, and becomes increasingly less as the material gradually decomposes. Fire lanes left every few rows minimize fire hazard, even when the mulch has just been applied. As far as insect control is concerned, with the increased knowledge of insect control and better equipment now available, the use of mulch should not present insurmountable obstacles. The fourth major objection, namely, that a surplus of nitrate may produce fruit of rather poor color, may be justified, although the evidence on this point does not seem to be very conclusive. Viewing the objections, it seems that careful attention to all these details in the management of an orchard are essential under any practice of soil management if it is to be successful.

The amount of mulch which has been used by the various growers throughout the Northeast varies from 3 to 13 tons per acre, depending upon the depth and the extent used. To be most effective, a mulch should be approximately 6 inches deep over the area covered, which in most cases means the ground under the spread of the branches, with the exception of the area immediately surrounding the trunk which is left bare for protection against mice. The following table by Prof. M. A. Blake,[6] of the New Jersey College of Agriculture, gives amounts generally recommended for apple trees in that State. In general, they are approximately the same as other growers throughout the Northeast are using, with the amount varying in proportion to that available at any particular time.

Mulch material required for apple trees per acre

Distance	Number of trees	Tree spread	Area covered	Mulch required *	
				A	B
		Feet	*Square feet*	*Pounds*	*Pounds*
40 by 40	27	25	13, 230	4, 410	7, 560
40 by 40	27	30	19, 089	6, 363	10, 908
40 by 40 **	52	25	25, 480	8, 493	14, 560
40 by 40 **	52	30	36, 764	12, 255	21, 008
20 by 20	103	15	12, 116	6, 372	10, 923

* A. One pound per 3 square feet; B. 1 pound per 1.75 square feet.
** With trees interplanted in centers of squares.

On the whole, it appears that the use of mulch is definitely on the increase in the Northeast and that the benefits are becoming appreciated by a greater number of growers each year. The investment which is necessary for fruit growing in the way of spraying equipment, warehousing, supplies, etc., together with the need for maintaining soil fertility and a productive site, is so great that minor production problems should not interfere with the major objective of the commercial grower.

[6] M. A. Blake: Amount of Mulch Material Required by Apple Trees. Circular 286, New Jersey Agricultural Experiment Station, New Brunswick, N. J. June 1933.

Soil Conservation Service accomplishments as of June 30, 1939

Type of use	Planned for in cooperative agreements	Previous farm and ranch conditions	Increase
	Acres	*Acres*	*Percent*
Pasture and range	13, 546, 514	13, 034, 953	3. 9
Perennial hay land	567, 350	232, 883	143. 6
Cropland with winter protection, including cover crops and crop residues	2, 483, 434	1, 322, 559	87. 8
Erosion-resisting crops	1, 439, 754	1, 151, 660	25. 0

THE USE OF KUDZU ON CRITICAL SLOPES

By R. Y. BAILEY [1]

A critical slope protected by kudzu. The land, of moderate slope, was retained for row crops and the steeper portion above the corn was planted to kudzu in 1935. The kudzu is now in its fifth growing season.

ONE of the first steps in the development of soil-conservation programs was the division of slopes into classes and the formulation of land-use recommendations for each class. If each farm had contained the right proportion of land in each slope class, and if each field had been uniform in slope, the job of farm planning would have been simple. Under such ideal conditions, each field could have been converted to its proper use and given exactly the type of mechanical and vegetative protection that it required.

Under field conditions, however, it was found that the degree of slope varied within individual fields to such an extent that uniform treatment was not feasible. In many fields in the Southeast, areas of steep land occurred where normal treatment was inadequate. These areas were steep slopes usually flanked above and below by land of moderate slope that was needed for the production of clean-tilled crops. Obviously, where this slope condition existed it was not feasible to retire the entire field from cultivation.

On the other hand, where the steeper areas were terraced and cropped along with the land of moderate slope, terraces became silted, overtopped, and broken during heavy rains with serious damage to land lying below. The steeper areas had usually lost most of their topsoil and produced sparse growth of most of the crops planted on them. In many cases, the soil on these slopes was too poor and too badly eroded to produce sufficient growth of the annual close-growing crops ordinarily used to control erosion or to increase soil fertility.

In January 1937, these steep slopes of the Southeastern region were designated as "critical slopes" and special treatment with deep-rooted perennials, that would withstand drought and produce effective cover, was recommended for them. The name was accepted rather generally by farmers and agricultural leaders and was helpful to those working in the field in that it called attention to this particular slope condition. Soon after the name was applied field workers were looking for and recognizing these slopes, whereas in the past they had failed to notice them. This was very helpful in developing the power of observation and also in giving field workers a starting point in working out vegetative treatment for individual fields, particularly in the row-crop section where little protective vegetation had been grown previously.

Kudzu was one of the plants selected for use on critical slopes. This plant had been used extensively for many years as a shade around buildings, to a considerable extent as a gully-control plant, and to a

[1] Chief, regional agronomy division, Southeastern Region, Soil Conservation Service, Spartanburg, S. C.

limited extent for forage and grazing. Its use in cultivated fields had been very limited prior to the organization of the Soil Conservation Service, except in a few localities. At the time that it was first employed for erosion control in Service project and camp areas, most farmers were rather strongly prejudiced against it. They thought of it as an aggressive plant that would spread very rapidly and become a dangerous pest if planted near cultivated fields. Many of them had been told that if they allowed one plant to get started it would soon overrun the entire farm and make further cultivation impossible. Many technicians in the Service also considered kudzu a dangerous pest and were opposed to its use except in isolated gullies or hopelessly destroyed areas separated from cultivated land by roads, streams, or woods. Agronomists in the Service and at agricultural colleges, however, knew from direct experience with the plant that its habits of growth made it easy to control. They knew that, where kudzu was planted on land adjacent to cultivated areas, the plowing necessary for the production of row crops would prevent any undesirable spread to cultivated areas.

Farmers on whose land kudzu had been planted in 1935 and 1936 had learned that many of the stories concerning its aggressive habits were overdrawn, and they were willing by the spring of 1937 to allow its use on critical slopes through their best cultivated fields. This willingness was due in large measure to the fact that they had learned from experience that critical slope areas were expensive to maintain in cultivation and that their returns from such areas were far too low to justify the expense of cultivation. Many of them had also learned that the cost of terrace construction and maintenance was much greater on these areas than on adjoining land of moderate slope.

After a few farmers in each community planted kudzu on critical slopes through their cultivated fields, their neighbors decided that it was less dangerous than they had thought. The changed attitude toward kudzu is strikingly illustrated by the fact that of the approximately 40,000 acres planted in demonstration projects, C. C. C. camp areas, and soil conservation districts during the past 3 years, more than one-third was planted in strips through cultivated fields.

Kudzu is proving popular on critical slopes because it is a deep-rooted, perennial, deciduous vine that gives protection against erosion during the entire year. The dense growth of vines and foliage provides effective protection during the growing season and serves as a perfect first line of defense during heavy rains. In many instances where terraces above these strips have been broken during heavy rains, the flood water has been brought under complete control by the strip of kudzu lying below—flood water is relieved of its load of silt so that the terrace and the land below are protected from serious damage.

After the top growth of kudzu is killed by frost, the vines and dead leaves give complete surface protection during winter. When it is considered that stubble from a small grain crop, or a very light mulching of straw, reduces materially the amount of run-off it may be understood that a layer of leaves and vines 2 to 4 inches deep over the entire surface is of great benefit in reducing water loss. Except during periods of prolonged heavy rainfall, the run-off from an area that is well covered with kudzu is neligible.

In addition to the typical critical slope which lies between two areas of land of moderate slope, there are many other types of steep slopes that are being designated as critical slopes and given the same type of treatment. In many places the land on the upper part of a field slopes moderately down to a certain point from which the slope increases rapidly throughout the remainder of the field. Again, the upper part of a field may be very steep down to a certain point where there is a decrease in slope continuing throughout the remainder of its length. In either case, the portion of the slope that is considered too steep for the production of row crops is planted to kudzu.

On many farms there are long uniformly steep slopes that do not have sufficient acreage of moderately sloping cropland to produce the crops required on the farm. If all of such fields were planted to kudzu it would be impossible for farmers to produce the necessary row crops. If, on the other hand, the entire fields were kept in row crops, it would be only a question of time before the land became so completely destroyed that it could no longer be utilized for crop production.

These steep fields are being protected by planting every second or third terrace interval to kudzu. The intervals between the kudzu strips are used for row crops, with the fullest feasible use being made of close-growing annuals in the rotation. There is a distinct possibility that, after kudzu has become well established and produces a heavy cover for 2 or 3 years, it will be found feasible to develop a long-time rotation between kudzu and row crops.

Work along this line was started in the Dadeville, Ala., area in the spring of 1939. Two strips through

established stands of kudzu were disked, turned, and planted to corn. The growth of corn on these strips was excellent, and only one cultivation with the plow was necessary. If a satisfactory rotation system can be developed between kudzu and row crops, on fields of uniformly steep slopes, farmers can continue to utilize land that is generally considered entirely too steep for row-crop production. Such a rotation will make it possible for many farms to continue to support people indefinitely, whereas without proper treatment these farms are doomed to destructive erosion and abandonment.

In addition to its direct benefits for erosion control, kudzu produces forage that is needed on the farms. The lack of other sources of forage forces a large proportion of farmers to harvest vegetation grown in rotations that should be left for soil conservation and improvement. Observations made in a camp area in the Piedmont section of Alabama, in the fall of 1938, illustrate the importance of dependable sources of forage in connection with a soil conservation program. The farms in this camp area are small and the slopes are unusually steep. The urgent need for forage has caused farmers to cut the tops of corn above the ears for stover, to pull the fodder below the ear, and to cut the soybeans from between the hills of corn for hay. All these operations were done by hand labor, making labor costs unreasonably high. The land from which this expensive forage was stripped was left bare of vegetation and was therefore completely exposed to erosion during the winter months. A considerable portion of the 1,400 acres of kudzu planted on farms under agreement in this camp area is being harvested for hay during the summer and fall of 1939, and additional acreage will come into production each succeeding year.

Production of hay from kudzu will enable farmers to establish improved rotations wherein annual legumes and grasses may be used for soil conservation and improvement instead of being harvested for forage. The improved rotation will result in larger acre yields, and farmers can then plant a larger proportion of their steep land to perennial forage crops thereby further improving their conservation program.

Kudzu grown on critical slopes will also have an important effect on the pasture program in the Southeast. On a large number of farms the acreage of pasture is inadequate, and overgrazing becomes a serious problem during periods of summer drought. By enclosing strips of kudzu with temporary fence, a few weeks' grazing during dry periods will be permitted; this will prevent serious overgrazing of pastures and will maintain livestock in good condition. The increased amount of hay and grazing supplied by kudzu grown on critical slopes results in increased production of meat and milk for consumption on Southern farms.

Thus land formerly considered worthless for crop production and a plant once despised and neglected have been brought together by proper land use to provide the foundation for a sound vegetative program. The production of high-quality hay from low-quality land is enabling farmers to plan a better type of soil-conserving rotation on other portions of their farms. Results accomplished in the treatment of critical slopes with kudzu suggest limitless possibilities for the employment of other little-used plants in the development of a soil conservation program.

TENNESSEE COVERS THE SOIL FOR THE WINTER

By R. H. MORRISH [1]

TENNESSEE is conducting a carefully planned, methodical campaign to put agricultural lands under grass over winter. The movement is significant, for Tennessee has 4 million acres of row crops, most of them on highly erodible soils.

The need for the campaign dates back to the days of "When you see the smoke from your neighbor's chimney, it's time to move." When Virginians and Carolinians pushed their way past Cumberland Gap into the Wilderness, they found Indian tribes growing legumes, "also rye, oats, myllet, along with their corne." The settlers chose corn, and by the middle of the nineteenth century led the Nation in corn production.

Corn is a soil-depleting crop.

At the height of corn production, Solon Robinson, pioneer Indiana agriculturist and traveler, declared that "this land needs Bermuda grass, for this is a land

[1] Chief, regional agronomy division, Ohio Valley Region, Soil Conservation Service, Dayton, Ohio.

Turf oats and vetch seeded in cotton middles. B. T. Scruggs farm, Gibson County, Tenn.

of gullies." But tobacco came next and cotton, and today millions of Tennessee acres show the consequences. Some of them are gullied, some are completely destroyed and most of them are worn, for 50 inches of rainfall come down on Tennessee soils each year.

In 1935, H. S. Nichols, now assistant director of the Tennessee Agricultural Extension Service, and H. E. Hendricks, Extension agronomist, gave serious thought to the problem and started a winter cover crops campaign. When they surveyed the State, they found that very few farmers covered their land over winter. In the Highland Rim country and in east Tennessee, small grain was used. Franklin County used a large amount of crimson clover, but Franklin County had long been a producer of crimson clover seed. Nichols and Hendricks decided that more legumes, particularly crimson clover, would help greatly in solving Tennessee's serious erosion problem.

They found many obstacles. Late cotton picking was one and lack of adequate seed in certain counties was another. Farmers did not want to cut and shock their corn and disk under the stubble. It was apparent, very early, that the campaign must be on a community basis and that a comprehensive cover crop program called for a large organization. Through county agricultural agents all agencies directly or indirectly concerned with land use were asked to help and county meetings discussed and planned action programs for the solution of major problems confronting each community. The county meetings were followed by community meetings where the ultimate goal was attained, for here the farmers came in large numbers, saw the seriousness of the problem and agreed to put their land under cover.

These community meetings were headed by the county agricultural agents supplemented by specialists of the Extension Service, Soil Conservation Service, T. V. A., the experiment station and college of agriculture, and the A. A. A. Instead of meeting in courthouses or schoolrooms, the groups went to demonstration farms set up by the Extension Service in cooperation with the T. V. A. There they saw for themselves the advantages of crimson clover and vetch and Austrian winter peas. Nearly 900 of these

(*Continued on p. 54*)

BERMUDA—ONE-TIME PEST—NOW A SOUTHERN FAVORITE

By EDGAR A. HODSON [1]

IN Australia it is known as couch grass. In California where its aggressiveness has been feared, it is called devil grass. Virginia farmers recognize its tenacity; they call it wire grass. In other places it is dogtooth grass, Bahama grass, Scotch grass. But throughout Arkansas, Louisiana, Texas, and Oklahoma, the farmers call it Bermuda.

Happily, the mass of Southern and Southwestern farmers are beginning to realize what a few have known for a long time—that Bermuda provides profitable utilization of eroded land; that it is one of the most effective base pasture grasses yet introduced in the South; that it is one of the best all-around erosion control plants ever used in the South and that it is an excellent soil builder.

Conservation farmers throughout this region have taken a cue from men like Harry Kelly who brought a shoe-box full of Bermuda, from Missouri, to his farm near Fort Smith on the Arkansas River in 1887 (he now has 2,000 acres in Bermuda), and F. A. Mitchell, "Father of Bermuda," in Oklahoma. They have cast aside their prejudices against this grass. They have learned to make it serve them instead of regarding it as a pest simply because they heretofore have not seriously considered methods of controlling it.

Fortunately, this new concept of the value of Bermuda grass in the average farming enterprise is based on a realization that grass is a profitable crop and as such deserves the same attention and consideration as any other crop regarded as an integral part of the farm program.

Regarded in this light, grass is no longer considered as an expedient for a specific purpose such as the treatment of land so badly eroded that it can be used for nothing else. A belief that grass may occupy land as good as that occupied by any other crop means that grass once more is coming into its rightful place on the farm. The fact that grass also cures gullies, serves to improve pastures, stabilize eroded areas and protect watersheds follows as a matter of course when it is given an equitable share of the land in the average farm. In Region 4, Bermuda grass has been accorded an important place in the farm program and is being used to perform a dozen needed jobs on the farm.

Bermuda grass thrives well in the four States of the region, as far west as the line marking the beginning of the belt which receives less than 25 inches of annual rainfall.

Of first importance is the fact that Bermuda is one of the most effective plants known for use as a base pasture grass throughout most of the region. Its forage value compares favorably with other pasture grasses but has the disadvantage of providing limited grazing during any hot, dry period in the summer and practically no grazing during the dormant season of winter. But this disadvantage has been mitigated in Region 4 by the overseeding of Bermuda pastures with adaptable legumes such as lespedeza, hop clover, white Dutch clover and bur-clover. This practice tends to lengthen the grazing season and to give the pasture the benefit of the soil-building properties of the legume.

Since Bermuda is readily established on most soils in the region and is a good forage plant, its value in an erosion control program cannot be overemphasized. Where care is exercised in the sodding operations, a good stand of the grass can be obtained within a year's time on most farms in this region.

Results obtained from the cultivation of Bermuda sod, in the establishment of new pasture areas, definitely prove the value of the practice. Survival in most instances has been satisfactory, and the spread of the grass has varied with the different methods of sodding used and the treatment given. On areas where there was no soil preparation and where the sod had not been cultivated, the spread of grass usually was very slow. Where the land was prepared by flat-breaking before the sodding, or the grass sodded with a cultivated crop, an excellent growth and spread of the grass was secured. A rapid spread and growth of grass has been obtained from sod placed in the rows at corn-planting time. The cultivation given the corn keeps down noxious weeds and grasses, scatters the sod, and provides a soil condition favorable to the spread of Bermuda.

If Bermuda is to be sodded with a cultivated crop a tall-growing plant, with foliage that is not too dense, should be used so that the grass will not be shaded out.

Bermuda also is being used extensively in Service demonstration areas and in soil-conservation districts for individual terrace outlets, terrace outlet channels, meadows, gully control, stabilization of eroded areas about the farm for the establishment of wildlife

[1] Chief, regional agronomy division, Western Gulf Region, Soil Conservation Service, Fort Worth, Tex.

A Bermuda grass meadow on the farm of C. T. Douglas, Guy, Ark., which utilizes idle land, provides a safe area on which terrace water from the adjoining field can be outletted, and furnishes an excellent hay crop.

habitats, revegetation of existing pasture areas, and roadside erosion control.

In addition to controlling erosion, the use of Bermuda grass for a variety of purposes has resulted in profitable utilization of the land which the grass protects. The establishment of pastures on land which could not be profitably utilized for other crops has given the farmer additional pasture. Bermuda meadows have been established on land formerly permitted to lie idle, such as natural drains grown up in weeds and sprouts, and other odd corners about the farm. This practice has provided erosion control, protected areas on which terrace water can be outletted, and furnished an extra hay crop.

The fencing of terrace outlet channels has made it possible for them to be used as pasture where pasture areas are adjacent to the channel or can be connected with the channel. This practice keeps down weeds which may compete with the grass and provides economical and practical maintenance of the channel.

The old fear that Bermuda, once given a foothold, will spread into the fields, choke out the crops and generally overrun the farm, is being allayed by simple control methods. The method most widely used is that of planting border strips around fields next to Bermuda grass pastures, meadows or channels, so that the plants in the border can serve as a balk to stop the Bermuda before it reaches the field.

But the experience of farmers and their own revised attitude toward Bermuda is the most convincing proof of the new light in which this grass is regarded in the South today.

There is, for example, the experience of the Brantley brothers, Jesse and John, of Farmerville, La. The adjoining Brantley farms are located on a slope, Jesse's on the top of the hill and John's at the lower end of the slope. When conservation systems were established on these farms in 1935, a joint terrace outlet channel was planned. Jesse readily agreed to the establishment of a channel sodded to Bermuda grass, but John refused to permit the use of this grass on his half of the channel. Hence that part of the channel on the Jesse Brantley farm was economically established by excavating for the channel and sodding with Bermuda, while that part on the John Brantley farm was protected with expensive concrete structures. During the winter of 1935 and 1936 John noticed that his channel was scouring badly and that silt was being deposited on his pasture while the Bermuda channel on Jesse Brantley's farm was performing perfectly. Thus it was that in the spring of 1936 John Brantley requested Service technicians from the Farmerville project to help him remove the concrete structures and sod the channel with Bermuda.

"I objected to Bermuda in the outlet channel because I thought it would spread into my fields. After trying concrete spreaders in the channel I learned that the most practical control method is Bermuda grass. I work my fields the same as I did before and I haven't noticed any Bermuda in them since I sodded it in the outlet channel." Thus John Brantley now defends the grass he once refused to have on his farm.

Noah Deering, progressive farmer of Harrison, Ark., said recently that a 22-acre Bermuda grass and lespedeza

171505—39——2

pasture (established 2 years ago) this year returned him $396 in the form of weight gains made by 22 steers that have grazed the pasture.

He said that the 22-acre pasture furnishes sufficient forage to support 22 head of steers 6½ months of each year, and that their average weight gain during this period is 300 pounds. Based on a price of 6 to 7 cents per pound received when he sold his steers, Mr. Deering figures that the pasture paid him $18 an acre this year.

"A few years before I established this pasture I planted the 22 acres in oats but did not harvest enough to pay me for the seed I put out," he said.

R. L. Folts of Greenbrier, Ark., in the Conway project area, gives credit to Bermuda, lespedeza, and hop clover for doubling the carrying capacity of his pasture. "A 42-acre pasture, which 3 years ago did not furnish sufficient forage for 6 head of livestock, now carries 13 head with ease," Mr. Folts said. "And this pasture which was sodded with Bermuda and overseeded with lespedeza and hop clover is capable of supporting 25 animals."

Alfred Ballman of Riesel (near Waco, Tex.) found a profitable use for 11 acres of idle land when he converted the area to permanent Bermuda grass pasture. "This idle area, situated along a natural drain, was too wet for use in cultivated crops. It was cleared and sodded to Bermuda and now furnishes forage for my livestock as well as a protected area on which I can outlet terrace water," he stated.

These examples could be multiplied many times over, since they represent a cross section of farmer opinion on Bermuda in Region 4.

Probably of equal significance in this trend toward grass consciousness in agriculture is the fact that many conservation farmers in this region are now considering the use of Bermuda grass in a long-time crop rotation—resting cultivated land with grass.

TENNESSEE COVERS THE SOIL

(*Continued from p. 51*)

community gatherings were held in one summer, with an attendance of more than 30,000 farmers.

At the end of the first campaign in 1935, 520,000 acres were covered up over winter, mostly with small grains. In 1936 there was a serious set-back, when drought hit hard and many seedlings failed; but an intensive drive was made to include more legumes in the rotation and by 1937 the acreage protected had soared over the million mark, a fourth of which was in winter legumes. The program has made progress through the years.

Even more valuable than the actual protection to the soil is the fact that farmers understand the value of lime and phosphate materials, how the different cover crops can be utilized to build the land and at the same time increase their farm income, and how to guard against erosion. Alfalfa acreage has more than doubled in 6 years.

From a study made of the production of over 2,000 livestock farmers, it was apparent that the weakest link in the pasture program in Tennessee was winter pastures. At the present over 100 days of extra grazing are being obtained by farmers who are using cover crops. The majority of these demonstrators use crimson clover as the base of winter pasture.

The 1939 goal is 2,000,000 acres—half of the row-crop acreage—and Nichols and Hendricks are confident that it will be attained. Indications are that the largest acreage ever seeded to winter cover crops in Tennessee will be sown as a result of this State-wide campaign. Nor are other soil conserving practices being neglected at the community meetings; the effects of close-growing sod crops, properly constructed terraces, strip cropping, contour furrowing, pasture improvement, contour tillage and other conservation farming practices widely adapted by farmers are being emphasized. Tennessee plans to go into the next winter under cover.

Like other States, Tennessee is approaching its problem from the community standpoint. Its extension education has long been through the community approach. Two years ago, G. S. Hollingsworth, extension soil conservationist, chose 10 communities as proving grounds and today it can be said that hope has returned to residents of these communities through demonstration projects. Once discouraged and ready to cease trying to earn a living from badly eroded lands, farmers have taken new heart. They are using winter cover crops, they are building terraces, and even the women help in building check dams and assist in planting trees. The county agents and the home demonstration agents will tell you that the community organizations have improved farm morale.

Farmers in Madison County scarcely knew the meaning of winter cover crops when the Service began operations through a C. C. C. camp in 1935. Whereas only 30 acres on farms cooperating with the Service were so protected then, today well over 2,000 acres on such farms are in bur-clover and crimson clover, Italian ryegrass and vetch, during the winter months.

PROTECTED WATERWAYS

By HARRY H. GARDNER [1]

Grassed waterway on farm near McGregor, Iowa. Typical of the well-maintained waterways in this area.

WATERWAYS trace the pattern of erosion on the landscape. They trace, too, the physical outlines of erosion control. When a watershed "cracks up" through erosion, the cracks run along flowage lines. As erosion takes its toll of soil and fertility, the network of flowages, branching out from the central stream to every part of the drainage area, marks the patchwork of watershed disintegration. Gullies reach out from the central stream, eat through depressions where run-off concentrates, cut back finally through upland fields. Along these open wounds runs the lifeblood of the farms—liquified topsoil, mobile under the lash of rain. Thus, in a very real sense, erosion control is watershed control.

Logically, the focal points of our erosion attack are along these drainages where run-off concentrates. The control problem is intensified where surplus water piles up and speeds downward, and here the effectiveness of control work is most accurately measured. Our entire control program—changed land-use patterns, correct crop rotations, contour tillage, strip cropping, and the rest—can be defined fairly accurately in terms of waterway protection, for the upland control measures keep run-off and siltation through drainageways at a minimum. The upland practices reinforce the control measures applied at the points where run-off concentrates.

[1] Chief, regional agronomy division, Upper Mississippi Region, Soil Conservation Service, Milwaukee, Wis.

The objective is to develop the waterways into safe transportation systems for suplus rains—to lead run-off from ridge to river with a minimum of damage along the way. This involves all possible means of protecting the waterways, normally with vegetation—trees or grass.

Agronomists in the Upper Mississippi region have placed great emphasis on the development of grassed waterways in connection with contour tillage, strip cropping and terracing. In each farm plan, conservationists have stressed complete protection of upland drainages, to prevent cutting through contoured rows or strips.

Both seeding and sodding have been used in establishing protection against surplus rain—sodding where time is an important factor, seeding where time is of less consequence. Sodding has been extensively used in Service projects and camp areas because of the need to establish effective demonstrations as quickly as possible. It is realized, however, that most farmers will use the seeding method, and in fact a number of excellent waterway seeding demonstrations already have been developed.

Bluegrass sod has been used exclusively for sodding purposes and in most instances for waterway seeding. Generally, sodding is confined to small areas because of the labor involved in cutting, moving, and laying sod strips. In many areas a combination of sodding and seeding is the chosen method. Where a large

amount of sod is needed a sod cutter is used, either the sled type or the rolling colter with the latter preferred. Pulled by team, tractor, or truck, this equipment will cut from 200 to 400 square yards of sod per hour.

The importance of setting the undercutting knife to obtain thin slices of sod cannot be overstressed; for average conditions the strips should be approximately 1½ inches thick, though in very dry periods they may be somewhat thicker. Sod more than 1½ inches thick cannot be easily rolled and is more difficult to lay because dirt is knocked off from the longer roots during transportation, and this makes the bottom of the strip uneven. The thinner strips establish themselves more readily because more roots are found in the upper level immediately below the crowns of the plants; also a thin sod responds more readily to tamping and makes a better contact with the soil. Wire netting is generally used to hold the sod in place while it becomes established.

Where sod is to be laid on subsoil as in eroded areas or in constructed terrace outlets, fertilizer, and lime if it is needed, should be first applied. Good barnyard manure is often used effectively.

Seeding mixtures for waterways vary so widely among different localities that no general recommendations can be made. Bluegrass with timothy and shallow-rooted legumes form common seeding mixtures in Wisconsin, Minnesota, Iowa, northern Illinois, and northern Missouri. Such a seeding eventually results in the formation of bluegrass sod. In southern Illinois and southern Missouri, redtop is seeded in a mixture with timothy, lespedeza, and alsike. In wet or poorly drained spots, reed canary grass is often sown; and sometimes plugs of slough-grass (*Spartina pectinata*) are dibbled into such soils. Of course the purpose of all mixtures is to provide effective protection while the dominant species becomes established.

Deep-rooted legumes such as alfalfa are not recommended for use in waterways because of their tendency to bunch—they do not provide sufficient protection as they cause concentration of run-off within the waterway during periods of heavy rain.

As to the relative value of seeding and sodding, agronomists in the Upper Mississippi region are often heard to say, "In terrace outlets use sod and sometimes seed; in natural waterways use seed and sometimes sod."

As soil conservation districts assume leadership in erosion-control work it is probable that the tendency will be toward increased seeding rather than sodding of waterways and no doubt even terrace outlets wil be prepared by seeding in the district areas.

The protected waterway should be wide enough to care for all the water likely to come down it—and this is emphasized because often the protected area proves too narrow to be effective. Widths vary from 20 to 100 feet, depending on the amount of water to be carried and the steepness of slopes on both sides of the waterway. The grass should extend well back over the shoulders of the natural depression or the constructed outlet, as otherwise gullies are likely to form at the edges and the farmer will be troubled with two gullies where he had one before. As further protection against gully formation, the edges of the grassed area should be uneven, with numerous bulges and recessions, so that water will not flow straight down them.

Proper maintenance of the waterways is of course essential to their continued effectiveness. They should always be crossed at right angles when the fields are being plowed or cultivated. Equipment should be raised at the edge of the protected strip and set down only when the other side is reached. Waterways should be carefully inspected after every heavy rain so that weak places and washes may be repaired before serious damage is done. Thinning or weakening of the bluegrass stand almost always is evidence of depleted soil fertility, for which the obvious cure is a well distributed application of barnyard manure.

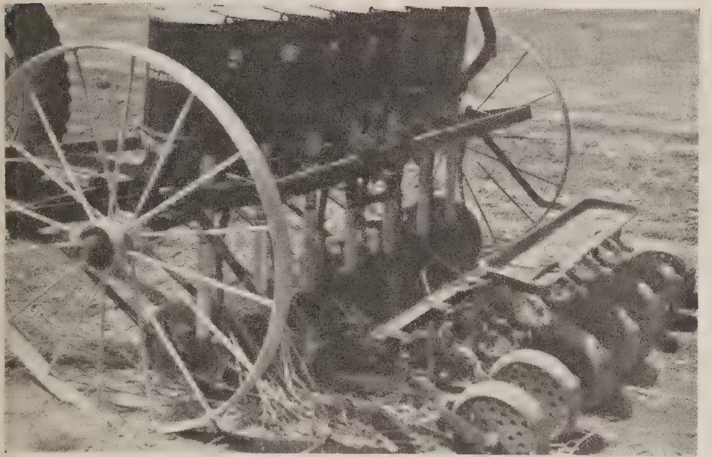
Grassed waterways cannot properly be considered wasteland. They may be used as convenient turning places during field operations, and they often provide good pasture—in many instances the hay grown on them is the best hay on the entire farm. But the chief purpose of waterway protection is to control erosion, and all other uses should be subordinated to this one. A dense sod is necessary to prevent washing, and to form a dense sod grass must be watered and fed.

Bluegrass should be clipped often enough each year to prevent seed formation and weed growth. Long grass lops over and catches silt, building up the channel unevenly and often diverting the course of the water. It should not be grazed during the hot, dry, summer months which form its dormant period, and grazing should cease early enough in the fall to enable the plants to store up reserve food for vigorous early spring growth. On waterways of any type, whether bluegrass or timothy, mowing is preferable to grazing, but the areas can be grazed without damage provided precautions are taken against overgrazing and against grazing in wet weather.

Thus managed, grassed waterways can do double duty for an indefinite period of time—produce feed for livestock and serve to protect the farm from deep gullies.

PROGRESS OF REGRASSING IN SOUTHERN GREAT PLAINS

By SIDNEY H. WATSON [1]



A combination grass and cover-crop disk drill fabricated by equipping a standard grain drill with combination corn and cotton boxes. Note the large seed tubes required for planting fluffy native grass seed.

OF THE 50 million acres of cultivated land in the southern Great Plains region, approximately 6 million are unsuited for cultivation and should eventually be retired to permanent vegetation. About a million acres of the crop lands are suffering severe wind erosion and should be retired to grass immediately; much of this land has been abandoned and is now a serious erosion hazard to adjoining lands. In addition to the cultivated land approximately 2 million acres of denuded range lands are in need of revegetation.

The need for adapted grasses for revegetation work in the Plains long has been recognized by leading scientists who have studied the existing problems. Probably the first experimental work on grasses adapted for revegetation under Plains conditions was initiated at the Department of Agriculture Grass Experiment Station at Garden City, Kans., in 1889. This work was expanded in 1890 and continued until 1892, when "on account of the reduction in the appropriation the Department was under the necessity of discontinuing the assistance afforded to state experiment stations in the prosecution of grass experiments, except in the case of the three States of Georgia, Mississippi, and Louisiana." Several native grasses including *Panicum virgatum*, *Andropogon hallii*, *Andropogon provincialis*, and *Andropogon scoparius* were included in these early studies.[2] Had this work been continued without interruption, no doubt many of the perplexing revegetation problems of today would long since have been solved.

As a result of land misuse, drought, and accompanying economic stress in the so-called Dust Bowl, in recent years it has become increasingly important that bad "blow lands" be revegetated to assist in arresting "black blizzards" and to bring about a more stable agriculture. State and Federal agencies have joined forces to perfect technique, while farmers cooperating with the Soil Conservation Service and other action agencies have worked with enthusiasm to establish a revegetation program.

Results of revegetation work by the Service have not been universally satisfactory, due in part to insufficient factual data and to drought conditions of recent years. In widely scattered areas of the southern Plains, farmers, in cooperation with the Service, had developed conservation practices demanding that large acreages "go back" to grass, and with this need in view seed of the native grasses once so abundant throughout the Plains were collected and planted. Some field plantings were successful; others were not.

Recognizing that more factual revegetation data were needed and that a concerted effort of all agencies was necessary, in January 1939 representatives of State and Federal agencies met in Amarillo, Tex., and outlined a plan for a further coordinated attack on the problem. This plan called for expansion of the work of the Bureau of Plant Industry, State agricultural experiment stations, and the Soil Conservation Service, and for close cooperation of these and other agencies in all phases of the work.

The Bureau of Plant Industry and the State Agricultural Experiment Stations agreed to expand their grass research programs as rapidly as possible. In addition to basic information pertaining to adaptation and methods of establishment, these agencies are conducting an intensive grass breeding and selection program and are assisting the Service in developing plans for evaluation studies, field trial plantings, and research projects, and are advising with regional operations technicians as to procedures to be followed in work units.

The Service also agreed to expand field operations—to purchase special equipment for revegetation operations, to carry on research work to the extent of its facilities, and to collect seed of native grasses for plant-

[1] In charge, revegetation program, Southern Great Plains Region, Soil Conservation Service, Amarillo, Tex.

[2] See report of the Secretary of Agriculture, 1892.

ing. Intensive studies are now under way at Amarillo and Dalhart, Tex., and at Cheyenne Wells, Colo. Nursery field trial plantings have been increased and in the spring of 1939 field operations were greatly expanded.

It was realized that grass seed broadcasted by hand had not given results comparable with those from drilling. Regular seeding equipment is not suitable for planting many of the native grasses, and with this in mind the State experiment stations, the Bureau of Plant Industry, and the Service have been working together to develop special drills for satisfactory seeding of native grasses as well as sorghums and small grains used for cover.

It was found that cotton boxes are very satisfactory for seeding most grasses, and using this finding as a basis, the Service developed specifications for use by implement dealers in fabricating the drills now in operation in this region.

The disk type drill will operate successfully in almost any type of cover, including large weeds and unharvested sorghums. It consists of a regular grain-drill frame equipped with combination corn and cotton boxes spaced 12 inches apart, specially constructed large seed tubes, furrow openers, and press wheels. With a variable speed transmission and cotton plates with varying numbers of seed openings, any desired rate of seeding can be made. Three types of furrow openers are used, depending upon soil and cover conditions: namely, the 18-inch single disk, the 18-inch double disk, and coulters and shoes.

Shovel-type drills are satisfactory for seeding on stubble land where soil blowing is not a serious problem. From the standpoint of moisture conservation, shovel openers are more desirable than other types even though some disadvantages are involved, such as destruction of cover, filling in of furrows which cover seed too deeply, and a seedbed not sufficiently firm. These disadvantages have been overcome in part, however, by the use of divided seed tubes, on a specially constructed drill, which place seed in the sides of furrows rather than in the bottom. This drill was fabricated by setting cotton boxes at 20-inch centers on a lister frame. By the means of the Y-seed-tube, seed is placed in the sides of 7-inch furrows giving an alternate drill spacing of 7″–13″–7″. The drill is also equipped with V-shaped rubber-covered press wheels, which aid in covering seed and firming the soil.

The first step in revegetation in areas subject to wind erosion is to prevent soil blowing while grasses are becoming established. Cover crops, including sorghums and small grains, are used extensively for this purpose. Drilling of sorghum in close-spaced rows of 12 to 20 inches affords the most satisfactory cover. Where conditions are not too critical, crops may be harvested to leave a 12- to 18-inch stubble although in many instances it is necessary to leave practically all forage on the ground to provide adequate protection against soil movement and to improve the physical condition of the soil. Mowing and leaving residue on the ground seems preferable to leaving the crop uncut, and this is particularly important if seed is produced by cover crop, as volunteer growth competes with grass seedings. Where severe soil blowing has occurred, it is impossible, in most cases, to establish adequate cover for grass planting in one year. Two or three years, or even longer, will be required to bring about satisfactory conditions for grass seeding.

Many fields where revegetation must be attempted are badly hummocked, and it is necessary to level the hummocks before a uniform stand of cover crop or grass can be expected. Where hummocks are small a lister is satisfactory for leveling, but often they are so large that a grader is required. The conservation of all available moisture greatly increases the chances of establishing both cover crops and grass. Contour tillage and seeding operations are essential for the best distribution and utilization of moisture on most soil types. Since close-drilled cover crops afford the best cover for grass seeding, these crops might best be planted with a shovel-type drill. Where two or more years are required to obtain satisfactory conditions for grass seeding, it may be advisable to plant the cover crops in lister rows, at least the first year.

Various experimental results show the value of mulch in conserving soil moisture and, of course, its value in preventing wind erosion is well known. In establishing grass on the more critical areas it may be necessary to resort to this practice, and, if so, the more crop residues left on the soil the better are the chances for establishing grass.

Weeds cannot be overlooked as a possibility in providing ground cover for initial stabilization and to produce a more favorable physical condition of the soil. The seeding of grass in growing weeds or in other growing crops is not generally recommended. With additional studies, however, it may be possible to develop methods of handling weeds whereby this natural cover can be successfully utilized for grass planting. It has been found that weeds, especially Russian thistle, mowed while still growing, will remain on the soil and afford protection against blowing, whereas if left uncut they often break off at the ground, leaving the soil bare and subject to erosion.

It has long been recognized that a firm seedbed is essential to the establishment of grass, and this point cannot be overemphasized. Often it is necessary to firm the soil with some type of land packer before or after grass is seeded.

Most native grasses must not be covered too deeply. On heavy soil the best emergence is obtained when they are covered to a depth of one-fourth to one-half inch, but on sandy soil they may be covered somewhat deeper.

Native grasses which are being used most extensively are *Bouteloua gracilis* (blue grama), *B. curtipendula* (side-oats grama), *Andropogon hallii* (western bluestem), *A. scoparius* (little bluestem), *Agropyron smithii* (western wheat), and *Buchloe dactyloides* (buffalo). Seed of most of these grasses may be harvested with combines, or hay containing seed may be scattered over areas to be revegetated.

All revegetation problems of the southern Great Plains will not be solved immediately, but definite progress is being made through the cooperative efforts of all interested agencies.

CRESTED WHEATGRASS ON DENUDED RANGE AND "GO-BACK" LAND

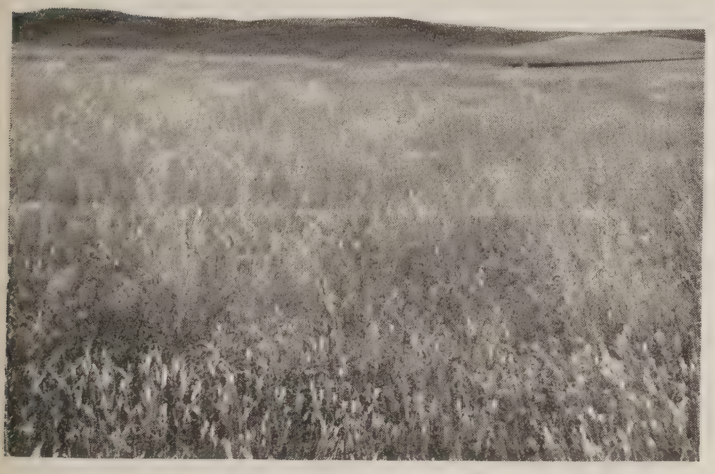
By WILKIE COLLINS, Jr.[1]

IN THE northern Great Plains region—North Dakota, South Dakota, Montana, Wyoming, and Nebraska—millions of acres of land are lying idle while no economic return is being derived from them. This condition was brought about by the subjection of large acreages of low-rainfall areas to the plow. Several good crops were produced after the native sod was turned under, but as the fibrous grass roots began to decay the structure of the soil began to break down and its organic matter and absorptive capacity decreased rapidly. The limited rainfall of the area which had permitted frequent plentiful crops of small grain no longer seemed sufficient for a permanent dry-land agriculture. The consequences are well known: Years of low rainfall, prevalent grasshopper infestations and high wind velocity left in their wake crop failures and drought stricken conditions and, in localized areas, a people with a badly shaken morale. Hundreds of farms were abandoned and millions of acres allowed to remain idle and unprotected from the ravages of wind erosion.

One of the important tasks of the Service in these areas is to demonstrate how the soil can be returned to proper land use and economic productiveness by the growing of adapted perennial grasses in a way similar to that of nature in the plains country. The use of proper grass species, proper rate, date and method of seeding idle lands, has been successfully demonstrated. During the past year, approximately 80,000 acres of perennial grasses were seeded on land utilization projects with a relatively high degree of success.

In general, grassland that has never been broken does not need reseeding. Such an area usually can be brought back to a productive state if grazing is restricted so that the sparse stand of grass may reproduce vegetatively and from seed when rainfall permits. Where the native vegetation is completely killed out, the practice of drilling the area to a grass-legume mixture, using a deep-furrow drill operated on the contour has been used. If the acreage is small on the individual farm, the denuded area is plowed in strips, the strip is cropped to small grain for one year and the grass seed is drilled in the small grain stubble late in the fall, with the intervening strips treated in a

[1] Agronomist, regional agronomy division, Northern Great Plains Region, Soil Conservation Service, Lincoln, Nebr.,



A field of crested wheatgrass in Montana. It was seeded in the fall of 1935.

similar manner the following year. The acreage of denuded range land that has been seeded is very small and consequently is discussed but briefly.

Before the Service started making recommendations and working out definite conservation plans on idle lands, a very careful and detailed study was made at the State experiment stations and Federal dry-land experiment stations to determine what grasses were proving most successful. Leading farmers and agriculturists in the various States were interviewed, and the agricultural workers of western Canadian Prairie Provinces were questioned in the effort to learn what grasses were proving most successful in their work and what methods of establishment were producing the best results. In addition to these investigations, a soil conservation nursery was set up in order to try out the various grass species and make determinations relative to adaptability and seeding technique.

A study of the collected information indicated very definitely that crested wheatgrass (*Agropyron cristatum*) is one of the outstanding grasses adapted to the northern Great Plains. Since it is a long-lived perennial bunch grass, crested wheatgrass has an extensive root system, is very drought-resistant, is a good weed fighter and is capable of going into a dormant stage during extremely dry weather. In addition, it is an early grass, producing palatable forage with a relatively high protein content and large quantities of viable seed that is easily harvested.

Grazing tests conducted for 20 years on the Ardmore Experiment Station, South Dakota, indicate that crested wheatgrass is very hardy and has approximately two and one-half times the carrying capacity of native grass species. The experiment stations at Archer, Gillette, and Sheridan, Wyo., have been successfully establishing crested wheatgrass for several years and grazing tests indicate high carrying capacity. Work with this grass at the Moccasin and Havre Experiment Stations, in Montana, have been outstanding: At Moccasin grazing tests indicated crested wheatgrass as superior to all other adapted grasses. On the northern Great Plains Field Station at Mandan, N. Dak., John Sarvis has worked with crested wheatgrass for more than 20 years. At the experiment station at Dickinson, N. Dak., Leroy Moomaw has had very successful results in his work with the grass. The results obtained in Canada were also very satisfactory, and many of the agricultural workers are enthusiastic about the results to be obtained from its use.

Even though crested wheatgrass was introduced into this country in 1898 from the cold, dry plains of Russia and Siberia, it had not attracted wide attention among commercial seedsmen of the northern Great Plains and available seed was not very plentiful. However, backed by the unusual success at the experiment stations, the Service decided to use crested wheatgrass as the principal grass in the program for the restoration of large acreages of idle lands.

The seeding of "go-back" or idle lands has now progressed sufficiently for technicians to recognize the merits and justify the confidence placed in crested wheat. The species used in the regrassing program have varied considerably with soil type, amount of precipitation, degree of erosion, kind and amount of vegetative cover, and the use to be made of the grasses.

In general, with the exception of the eastern one-third of South Dakota and the eastern half of Nebraska, and on irrigated lands, crested wheatgrass has constituted at least 50 percent of the grass mixture used in seeding abandoned lands. In practically all instances mixtures have been used, with a sod-forming grass such as western wheatgrass (*Agropyron smithii*) or smooth bromegrass (*Bromus inermis*) being added to the crested wheatgrass. In many cases a small quantity of white sweetclover (*Melilotus alba*) or alfalfa (*Medicago sativa*), depending on soil type, has been added to the mixture to increase the value of forage and add nitrogen to the soil. In adapted areas, crested wheatgrass has proved the most reliable grass seeded and about the easiest to establish. A common mixture used in reseeding idle land is 3 pounds of crested wheatgrass, 2 pounds of western wheatgrass, and 1 pound of yellow blossom sweetlcover per acre. This mixture has produced good results. However, in many instances 4 pounds of crested wheatgrass was used with 1 pound of western wheatgrass.

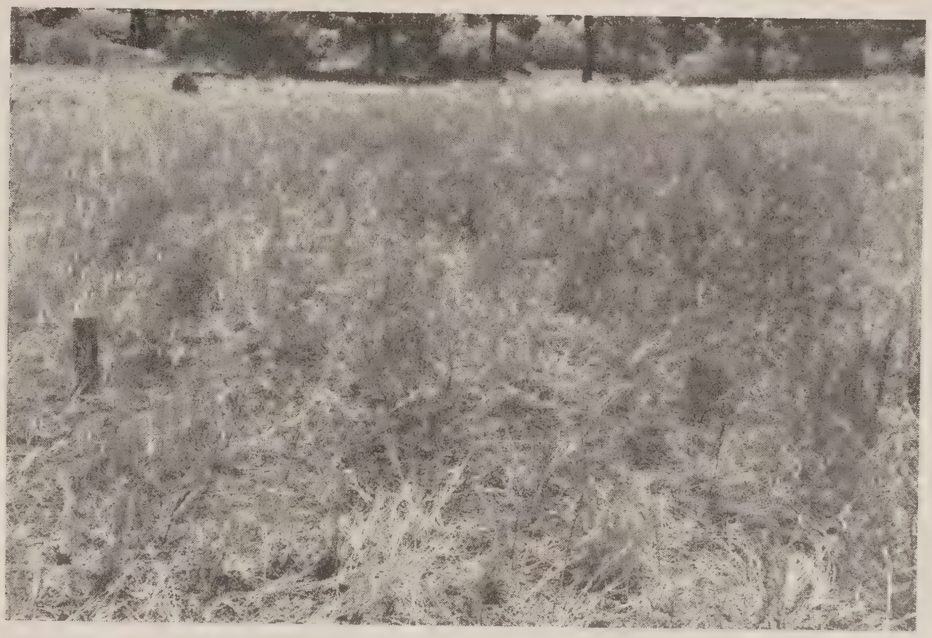
The most satisfactory seeding has been done with the small grain drill and using a grass seeder attachment for the clover. When the grass is to be drilled on the contour or in heavy stubble or on a weedy field, the single-disk, deep-furrow drill is recommended, as it will leave a larger furrow for moisture-conservation purposes. In light-textured soils or completely barren soils, however, the deep-furrow drill is not recommended as soil drifting will often cause the seed to be covered too deeply. The broadcast method is not used in the drier areas because the seed will germinate and then die after the soil has dried out underneath the seedling.

The date of seeding is very important, and as crested wheatgrass is a native cold-weather plant, many stands

(*Continued on p. 63*)

THE ROLE OF RESEEDING IN RESTORING SOUTHWESTERN RANGES

By EVAN FLORY [1]



Two and a half years before this picture was taken, this site was crisscrossed by a gully. Reseeding and protection from excessive grazing resulted in this luxuriant stand of western wheatgrass, crested wheatgrass, and sweetclover. Vegetation took a good hold and stopped active cutting.

TOO heavy utilization in the past of vast range resources, together with climatic limitations, has depleted the vegetative cover and set the stage for progressive man-made erosion in the Southwest.

As the more desirable forage species disappeared, the land was left partly denuded and partly covered by species of low erosion-control value often poisonous to livestock. With decreased density of cover came increased run-off with subsequent sheet erosion, gullying, head cutting, and wind erosion.

Rehabilitation of range lands depends largely upon natural revegetation through proper range-management practices. But depletion has proceeded so far in many localities that artificial means are needed to establish a vegetative cover so that erosion processes can be checked before soil conditions become altered to such an extent that revegetation is no longer possible. This is important, because the effectiveness of other conservation practices depends on an adequate ground cover.

The Southwest region is a land of extreme conditions. Annual precipitation varies from 3 to 40 inches. Growing seasons range from 30 to 365 days. Elevations range from 137 to 14,000 feet above sea level. In some parts of the region, annual precipitation comes largely as winter snow; in others, it is rather evenly distributed between winter and summer; and in some areas it is limited largely to late summer.

In response to these conditions, plant associations in the Desert Scrub, Sagebrush, Woodland, Prairie, Montane Forest, Subalpine Forest, Boreal Forest, and Tundra formations are encountered. Our major problem areas, however, are characterized by a long, dry period that lasts from early spring to July, often into August. Hence, the major limiting factor in our revegetation program is soil moisture.

Years of experience by the Forest Service, and later by the Soil Conservation Service show that it is a waste of time and money to attempt revegetation unless the grazing practices which caused depletion in the beginning are corrected. No attempt is made at artificial revegetation in solid blocks, or where stock concentrate, unless the management plan provides protection for young seedlings against grazing and trampling damages until they will withstand normal usage. Under most of our conditions, this requires two growing seasons, with use the year or two following limited where possible to the dormant period.

In the bunchgrass and wheatgrass associations in Utah and northern Colorado, with winter rainfall prevailing and where dry farming has been practiced, soil moisture is generally adequate for successful artificial revegetation by solid seedings. Ordinary preparation of soil for dry farm seeding operations is commonly satisfactory, but augmenting normal soil moisture by conservation methods increases the chances of success and yields.

---

[1] Range examiner, Southwest Region, Soil Conservation Service, Albuquerque, N. Mex.

In areas characterized by the grama association and summer rainfall, additional soil moisture provided by means of furrows, ditches, dykes, terraces, ridges, percolators, spreaders, etc., aid materially in establishing a stand.

Litter has been very beneficial in facilitating establishment of young seedlings in the more arid locations, by shading them from direct light and protecting them from direct wind. Straw containing much seed has been used effectively on dams, stock tanks, dykes, and other exposed areas; it is an expensive practice, however, that can be justified only on critical areas.

On range seedings proper, in the Pecos River section of the region, litter may be furnished by Sudan grass, cane or a similar annual crop planted the year previous to grass seeding. It should be a crop that will not reseed to compete with the grass seedlings.

We are fortunate in this region in that desirable pioneer grasses will succeed on the most eroded phases of many soil types. The inclusion of some climax species seed in the mixture provides scattered individual plants to furnish a well distributed seed supply for the whole area while the pioneer species create conditions favorable to succession toward the climax.

Introducing an efficient legume helps to improve both grassland and soil. Legumes commonly are excellent pioneers. To improve range and soil they must be essentially herbaceous, edible and palatable, aggressive and able to withstand grazing. Much work remains to be done in locating, selecting, and introducing desirable legumes.

We have found that seed mixtures are better than one species used alone because grasses vary in seasonal requirements, soil needs, rapidity of establishment, and persistency of stand. Consequently, a suitable mixture will bring a quicker stand, a more permanent cover, and higher yield than will any one species used alone.

The proportion of seeds of each species to be used in a mixture is based upon the proportion of individuals that usually survive establishment and competition between young plants. It is a waste of seed to sow small amounts of a weak species with large or equal amounts of a strong species. Recognition of these principles in the preparation of a seed mixture will satisfy the requirements of plant succession on areas of varying degrees of depletion.

We find that nurse crops use moisture badly needed by young grass seedlings and therefore we do not use them.

Time of seeding varies considerably in various parts of the region. Where precipitation is largely from late summer rains, seeding just before the rainy season is most desirable. But in areas with the major portion of the year's precipitation in the form of snow and early spring rains, seeding just before winter sets in has proved best.

Areas dominated by gramas, galleta, tobosa, and associated species generally are seeded best in late summer, as they need high temperatures for ready germination. Such areas usually have slight winter and spring precipitation and a very dry early summer with rains beginning in July. Ordinarily it is possible to begin seeding in the latter part of June, if a large seeding program is contemplated.

Areas dominated by bunchgrass and wheatgrasses are seeded best in late fall or early spring, as these species will germinate readily in rather cool weather. Moisture conditions are also most satisfactory at this period, since this habitat has relatively high winter and early spring precipitation with dry summers. Late fall is preferable to early spring planting, because the seed will remain dormant in the soil during the winter and will germinate on the first warm days in the spring while the soil is still moist from melting snows.

The amount of seed used in artificial range revegetation depends on quality and size of seed, number and character of the species in the mixture, etc. Generally, with most range species, about one viable seed per square inch is necessary for establishment of an adequate stand. Some of the quick starting and vigorous species can be sown at a slightly lower rate, and, conversely, some of the species which have very small weak seedlings that are slow to establish require a higher rate.

An old gardener's rule says that "seeds should be sown at a depth three times their own thickness." This, although not literally correct, implies that small seeds must be sown at a very shallow depth, while larger ones can be planted deeper.

When seed is sown in mixture, as is usually the case, we regulate the depth of seeding for the smallest seeds in it. Good results have followed seeding on the surface and squeezing the seed into the ground with a corrugated roller. Many of the revegetation failures have been due to seed being covered too deeply. Too deep planting has resulted from a seedbed that is too loose, from broadcasting on the surface and disking too deeply, and from seeding in the bottoms of furrows in which silt subsequently collected.

We have adapted machinery to the seeding conditions found in the Southwest region after considering these important factors: economy of operation; prepa-

ration of seedbed; seeding depth; firming of soil about the seed; ability to use the various kinds of seed in mixtures without stoppage and maintaining an even mixture whether the hopper is full or nearly empty. Modified seed drills are doing this very satisfactorily where they can be used.

Seeding in furrows is done by broadcasting with a modified dust blower. All the disturbed strip is seeded. Covering is effectively done by means of a light brush drag drawn by the operator of the duster. On freshly broken furrows, broadcasting the seed without the use of any covering equipment has been very satisfactory, as natural openings, clods, slacking of the soil, etc., cover the seed adequately.

We have obtained some good results from seedings on steep hillsides, arroyos, dams, banks, dykes and other locations where machinery could not be used, by broadcasting, then handraking and brush dragging and trampling by sheep. However, such practices are not as successful as drilling, and we use them only where drilling is not possible.

Great areas of sagebrush land present one of our greatest revegetation problems. These areas once were grassland-sagebrush savannahs, but overgrazing has practically destroyed the grass and the sagebrush has increased until it constitutes nearly all the cover. Erosion is very severe and carrying capacity is low.

The lessening of sagebrush competition is desirable in many areas before grass can be established. Experience to date indicates that in large areas, dragging down the sage is the most practical method. Seed broadcast before dragging is covered by the dragging operation. The sagebrush debris protects the ground surface against wind and water erosion, and the young seedlings against wind, sun, and too close grazing.

In the early days, many of the grass species adaptable to our region had not been tried, and revegetation had not been attempted to any extent under such conditions as are encountered in the Southwest. But during the past few years every conceivable method has been tried under our varied conditions. Although many of our efforts to date have not been too successful, they have supplied us with a fund of information which we feel justifies us in recommending extensive seeding operations in what we consider our more favorable sites, with proved species, by proved methods.

CRESTED WHEATGRASS

(*Continued from p. 60*)

are killed by hot winds occurring before the plant becomes well rooted. Late spring and summer seedings usually are unsuccessful for this reason and because of early damage from grasshoppers. The optimum date of seeding is from August 20 to September 20, provided there is ample moisture in the soil and grasshoppers are not prevalent. The next best seeding date is in the late fall, from about October 20 until the soil freezes in the late fall or early winter. Early spring seeding, before April 20, has proved the third best period.

The proper depth of seeding is a factor that cannot be too strongly emphasized. Many stands have failed because the seeding was too deep. As crested wheatgrass seed is rather small (there are some 200,000 seeds per pound) the amount of stored food in the endosperm is very limited and does not serve to push the seedling through a deep cover of soil. The recommended depth of covering is about one-half inch, and for this reason it is especially important that supervision be given the cooperating farmer in getting the drill adjusted and calibrated so as to assure proper coverage of the seed.

The grass seed mixture used in seeding idle lands is usually wasted unless the seeding is performed on a firm or hard seedbed that is free from all looseness and airpockets. The soil will "firm up" naturally if it is undisturbed, or if a small grain or Sudan grass crop is produced on the soil the first year and grass is seeded in the stubble after the crop has been harvested.

Where the land to be seeded has a vegetative cover, no additional seedbed preparation is needed. If the soil is barren and drifting, the grass seeding operations must be postponed until after a vegetative cover has been produced and the soil stabilized. This necessary vegetative cover can best be obtained by drilling the field to small grain, preferably rye or Sudan. Grass-seeding operations will then be carried out in the fall, following the emergency cover crop.

After it has been seeded special care should be given each field, until it becomes well established. This care consists primarily of withholding grazing during the first year and until the grass has started growth in the spring of the second year. Experimental grass plot work in Nebraska indicates that undisturbed grass produces, in a single growing season, twelve times as many roots as similar grass plots continuously clipped during the first year's growth. The top growth is very dependent upon the root developments.

The plan is that when idle or abandoned lands have been seeded to a perennial grass mixture and have

(*Continued on p. 67*)

This field of fall wheat stubble, averaging 3 tons or over per acre has been disked three times to a depth of 7 inches.

CROP AND TILLAGE ROTATIONS COMBINE FORCES IN THE PACIFIC NORTHWEST

THE environmental contrasts within Region 9 (Washington, Oregon, and Idaho) comprise a testing ground for seed, seed mixtures and residue utilization as applied to a wide range of conditions. Continued observation of practices is providing a basis for refinements of technique, and for determination of land-use capabilities as a general guide for site identification. The latter need has been met by "minimum requirement charts" prepared for each principal work area and based on land-use capabilities as determined by soil type, slope, and degree of erosion.

This approach to the development of a technique or formula to be followed in determining a safe, long-time cropping system has been found very helpful in developing a common understanding among the technical staff, as well as an appreciation of the problems on the part of cooperating agencies.

During the past 4 years on the Palouse project (Moscow, Idaho), sweetclover and grass rotational seedings that have been plowed under and cropped to wheat have produced an average increase of 12 bushels per acre over untreated land. Within the various portions of the intermountain wheat belt, where rainfall corresponds with that of the Palouse section, this practice has resulted in increased yields and improved soil condition.

Since the development of grass-legume rotational seedings to the point of maintaining a relatively constant acreage, an increase of approximately 20 percent in the number of cattle within the Moscow project has been reported. A definite trend is also noticed toward increased fall usage of this type of pasturage by range cattle from surrounding areas. Quick-growing semipermanent grasses are now being used with sweetclover for rotational seedings, and long-lived grasses have been included with alfalfa in permanent pasture and hay seedings. The proportion of grass to legume has been adjusted to meet soil and climatic conditions. Development and use of new grass accessions, made available by the soil-conservation nurseries, has been of outstanding importance.

Field trials are being conducted in cooperation with a few operators who will produce a limited number of outstanding accessions under the State seed-certifi-

cation program. Quotas have been established for "uncommon" seed—seed ordinarily not available through commercial channels. The operations program will require about 80,000 pounds in the fall of 1939 and spring of 1940, and 105,000 pounds during the fall of 1940 and the spring of 1941.

Although the more common commercial grass species, such as crested wheatgrass (*Agropyron cristatum*), slender wheatgrass (*Agropyron pauciflorum*), and smooth brome (*Bromus inermis*) have been extensively used in the past in rotational seedings with sweetclover, these grasses are not ideally suited to the purpose because of their slow-growing habits. It is thought that development of larger seeded, more vigorous growing species will pave the way toward increased use of grass with sweetclover. Among the more promising species being considered as substitutes are mountain brome (*Bromus marginatus*), blue wild-rye (*Elymus glaucus*), Canada wild-rye (*Elymus canadensis*), big bluegrass (*Poa ampla*), and perhaps bulbous barley (*Hordeum bulbosum*).

For permanent retirement, or for use in long rotations, a number of native and introduced species give promise of wider use to replace the common commercial species formerly included in seeding mixtures. In this group are the native bluebunch wheatgrasses *Agropyron spicatum* and *Agropyron inerme*, thickspike wheatgrass (*Agropyron dasystachyum*), northwest strains of western wheatgrass (*Agropyron smithii*), and the robust-growing introduced species *Agropyron trichophorum* or *Agropyron intermedium*.

In the vernal dominant group are Sandberg's bluegrass (*Poa secunda*), or the robust form, Canby bluegrass (*Poa canbyi*). Bulbous bluegrass (*Poa bulbosa*) is rapidly extending its range of use and is considered an important component in range reseeding mixtures.

Of the bromegrasses, improved strains of smooth brome (*Bromus inermis*) are coming to the front, and mountain brome (*Bromus marginatus*) because of its ease of establishment and wide adaptation is valuable. Erect bromegrass (*Bromus erectus*) is finding a place on severely eroded sites under areas of low to moderate rainfall.

Of the ryegrasses, blue wild-rye (*Elymus glaucus*) and Canada wild-rye (*Elymus canadensis*) are the most promising because of their high seed yield, wide adaptation and ease of handling. In the fescue group,

Idaho fescue (*Festuca idahoensis*) is an important component in the native vegetation; it has poor seed habits, however, and will require additional selection and breeding. At present, strains of sheep fescue (*Festuca ovina*) are promising. Robust and uniform strains of red fescue (*Festuca rubra*) are being increased and they may find general use where other fine-leaved fescues are adaptable.

Among the primary invaders for use in initial seeding of denuded areas, particularly those with light and sandy soils, are the ricegrasses, the dropseeds, the needlegrasses and the squirreltails. The most promising species are, in the order named, Indian ricegrass (*Oryzopsis hymenoides*), and the sand dropseeds *Sporobolus cryptandrus* and *Sporobolus airoides*. A species of needlegrass which is of particular interest in soil conservation is *Stipa viridula* because of its broad leaves, robust growth, recovery after cutting, and growth at low temperatures. Red three-awn grass (*Aristida longiseta*) is very abundant, particularly in overgrazed areas but, although it possesses some forage value in early growth, its seed characteristics discourage wide use. Of the squirreltails, *Sitanion jubatum* and *Sitanion hystrix* are common invaders of overgrazed areas. They are drought-resistant and they set seed abundantly and shatter readily. In the early growth stage they are readily eaten by livestock.

The advantageous use of rotational seedings and adapted species in vegetative protection of soil is effectively supported by tillage methods that enable utilization of crop residues. Field trials prove that the greatest value of crop residues lies in their maintenance as surface mulch during the critical erosion period. Farmers in areas subject to severe wind erosion have made the greatest progress in utilization of crop residues. Their efforts and those of men of the Service have shown that initial tillage operations can be adjusted so that the major portion of these residues can be left on the surface without interference with subsequent operations and with no adverse effects on production.

Because of climatic conditions, a typical problem is encountered in the utilization of residues in the wheat-growing sections of the Northwest. The zones of relatively high rainfall usually produce abundant straw, whereas in the lower rainfall areas, subject to wind erosion, residues usually are light. Protection of the soil during critical erosion periods requires a flexible tillage system to secure maximum benefits from proper use of residues. In every instance a surface cover of such residues is of primary importance. It is

(*Continued on p. 72*)

ORCHARD COVER CROPS IN THE PACIFIC SOUTHWEST REGION

By CHARLES B. AHLSON [1]

THE USE of annual or winter cover crops has been a standard practice for many years in irrigated citrus, avocado, and deciduous orchards in the Pacific southwest region. From the standpoint of securing maximum erosion control in hillside orchards, this practice is far from perfect, inasmuch as the soil is not protected from early rains in the fall of the year or from late rains after the cover is turned under in the spring.

Information gathered in a survey by the Service [2] of permanent or continuous cover on 23 irrigated orchards in California indicated that the practice was considered by these growers to be preferable to an annually planted cover. Permanent cover, combined with little or no cultivation, gave practically complete erosion control in these orchards. Cultivation costs were also reduced and the quantity and quality of the fruit produced averaged equal to or better than that of orchards where other cultural practices were followed.

A knowledge of climatic factors is necessary for appreciation of the erosion hazards encountered in California orchards. The bulk of the rainfall is in the late fall and winter months, and high intensities are frequently recorded. Usually the temperature is mild enough during the rainy season to permit the germination and growth of cover-crop seed. The critical period for cover crops is the fall of the year. It is difficult to establish adequate cover, early enough in the fall to check erosion, by depending on precipitation, and for this reason many growers irrigate so that a good cover can be established at the proper time.

Where a permanent or continuous cover is used, the soil receives maximum protection from erosion. Growers who follow the practice generally mow the cover and use it for mulching around the trees, or simply leave it where it is cut. A few of the growers who were interviewed do not mow the cover or disturb it in any way.

The type of plants used for continuous cover varies. Some growers perfer native annuals consisting of early maturing grasses and legumes, such as bromes, fescues, wild barley, and bur-clover. As a majority of these species germinte with the fall rains, enough seed generally matures to provide new growth in the fall. The old growth and litter give the soil some protection from washing while the new growth is coming up, and rank-growing weeds which mature seed later than the native annuals are gradually eliminated by mowing.

Some growers prefer a cover of perennial grasses and legumes, including Italian ryegrass, bluegrass, orchard grass, Ladino clover, white Dutch clover, and red clover. Alfalfa is also used, but in general it is not as desirable as the other species mentioned. In deciduous orchards, the growth is often pastured instead of mowed, if the grower has facilities for a combined fruit and livestock enterprise.

Those growers who were consulted by representatives of the Service stated that no specific or radical changes in pest control or fertilization were necessitated by a permanent cover.

For proponents of the practice of clean cultivation, attention is called to the reduction in orchard cultivation that has made steady progress in the last 10 years. In an article entitled "Putting Farm Efficiency Records to Practical Use" that appeared in the Extension Service Review for June 1939, by Harold E. Wahlberg, farm advisor, Orange County, it was stated that "over a period of years, the study shows that the more profitable orchards actually receive less cultivation than the less profitable orchards. In 1938, the 20 more profitable orchards of the 60 in the study reported an average cultivation cost of $9.67 per acre whereas the 20 least profitable orchards reported $16.13 per acre . . . A large majority of our orange growers have reduced their hours and costs of cultivation during the past 10 years about 50 percent, some even more."

Permanent cover can be readily established with a sprinkler system of irrigation. Where furrows are used for irrigation, the broad shallow type [3] is preferable to the V-shaped furrow, as it provides a more uniform seedbed. The erosion that usually occurs in the V-shaped furrow is largely eliminated.

The use of annual or winter cover in deciduous nonirrigated orchards is increasing. In the Corralitos demonstration area in Santa Cruz County, clean cultivation was the general practice until the last few years,

[1] Chief, regional agronomy division, Pacific Southwest Region, Soil Conservation Service, Berkeley, Calif.

[2] Permanent Cover in Irrigated Orchards, by Charles B. Ahlson and George Hutchinson. Soil Conservation, February 1939.

[3] Advantages of Broad Furrow Irrigation, by Colin A. Taylor, Pacific Rural Press, March 18, 1939, pp. 262–263.

although the county farm advisor had recommended the use of annual cover in hillside orchards. The inception of soil conservation demonstrations, and increasing appreciation of the erosion hazard on the part of the growers—gained by tours held by County Farm Advisor Henry L. Washburn in cooperation with the Service—has established the use of winter cover crops in combination with trashy cultivation. In the deciduous irrigated orchards of the Placerville demonstration area, approximately three-fourths of the orchards are now in permanent cover.

Avocado trees, uniform and vigorous in tree growth, density and height of cover. The orchard has not been mowed or cultivated since 1927. The man is pointing to the header irrigation furrow from which the water is diverted to individual tree basins.

Although there are a number of problems relating to the use of permanent cover, including that of water requirement, that have not as yet been solved, the value of the practice for erosion control is beyond question. At the present the Service is conducting evaluation studies on demonstration areas for clarification of some of these problems.

In a few instances, winter cover cropping has been combined with basin listing in deciduous orchards. On gently sloping land and permeable soils this practice is of value both as a soil and water conservation measure. In those orchards where the slope is steep and the soil relatively impermeable, it has not been successful.

The increased use of perennial or annual cover with a minimum of cultivation, or no cultivation, in irrigated orchards is striking evidence that growers are aware of the necessity of curbing erosion and of reducing the cost of cultural operations. The study that was made of 23 irrigated orchards where permanent cover is used included the principal orchard areas in California where erosion is a problem. The results indicated that this practice might be used to good advantage more generally in those areas as well as others. At least, further observations, studies, and tests should be made.

The growers usually gave five reasons why they use a permanent or continuous cover in their orchards: (1) It eliminates cost of annual seeding, (2) reduces cost of cultivation, (3) allows little or no soil loss, (4) allows less run-off, and (5) quality and quantity of production are equivalent to or higher than without cover.

CRESTED WHEATGRASS

(Continued from p. 63)

become established the grass will remain permanently on the field. However, for northern Great Plains areas of light-textured soil and higher rainfall, to be used for continuous cropping, the Service is recommending a long-time grass legume rotation: Part of the farm is to be seeded to grass to remain for several years, and then it is plowed and another part of the farm is seeded. By this arrangement, all the cultivated land will be in grass once in 20 years.

Crested wheatgrass plays an important part in this program, since Canadian experimental results indicate that it has a total root fiber content of 5,079 pounds per acre in the upper 6 inches of the soil. This enormous quantity of root fiber, when periodically returned to the soil in a long-time grass rotation, not only binds the soil, improves the soil structure, aids in balancing the carbon nitrogen ratio, increases the absorptive capacity of the soil, and minimizes erosion, but also assists in stabilizing farming operations and establishing a permanent system of agriculture.

HOW TO USE OUR GREATER ACREAGE OF HAY

By A. T. SEMPLE [1]

UTILIZING the hay crop is a subject of considerable concern to Soil Conservation Service field men who are helping farmers to replan their farms and ranches for soil and water conservation. Certain land-use capabilities call for certain crop rotations which involve the production of corn or other feed grains, and hay or other roughage, in a rather definite relationship. This results in a problem of utilizing these crops to the best advantage in feeding various kinds and market classes of livestock. Naturally, it is difficult to make much use of large amounts of hay or silage in fattening hogs or feeding poultry. On the other hand, a herd of beef breeding cows may be kept almost wholly on roughages, while fattening yearlings require a longer feeding period and a greater proportion of concentrates than do 2-year-old steers.

Of course, there may be some argument as to whether we should fit the livestock to the crops we should grow on the soils that we have, or try to adapt the soil to the production of crops necessary for the kind of livestock we want to keep. I believe we will be safer and come nearer effecting a permanent agriculture if we start our planning with the soil that we have and the physical conditions surrounding it, grow the crops, grass, trees and shrubs which are best adapted to the soil with adequate consideration for its protection, maintenance, and improvement, and keep the kinds of livestock which can make the safest and most economical use of the feed crops. As a matter of fact, most farmers do adapt the number and type of livestock to the crops which the farm produces to the best immediate advantage. In the exceptional cases, farmers purchase the feeds which the nature or extent of their land does not permit them to produce, but which are needed by the livestock they are keeping. This is especially true of operators who purchase carload lots of feeder cattle and sheep to be fattened for slaughter, and who keep dairy cows for fresh milk production on high-priced land near large cities.

Dependence by some farmers on purchased feeds, such as grain and hay, means that other farmers are following what is commonly called the grain system of farming and may be keeping only enough livestock to supply home needs for meat, milk, and farm power. Unfortunately, many grain farmers do not keep enough livestock to meet home requirements and must use the cash proceeds from their crops to purchase what they could have produced readily on their farms. Such uses of cash for goods which should have been produced at home naturally limits the improvement of farm living standards because it reduces the amount of cash available for the purchase of goods which farmers are not able to produce on their farms.

A friend of mine in the field of animal husbandry stated recently that there had been too much experimentation in the feeding of crops which should not have been grown. He meant by this that far more concentrated feeds such as corn, oats, cereal byproducts and cottonseed meal, have been produced than can be marketed profitably, and more than a fair share of research work and funds have been expended on the problems of utilizing such concentrated feeds in the fattening of livestock. This explains to a large extent the inadequacy of information on the use of hay, other roughages, and pasturage in growing and fattening livestock.

Paul Gerlaugh and C. W. Gay [2] of the Ohio Agricultural Experiment Station have conducted an excellent series of experiments, covering 3 years, which show the effects of reducing the corn and increasing the hay in the rations of fattening yearling steers with hogs following them to pick waste corn. Each lot of steers received 1.5 pounds of protein supplement and practically 14 pounds of silage per head daily, as shown in the following table.

*The rations and daily gains of yearling steers fattened on heavy, medium, and light feeds of corn and the acreage of feed crops required for such methods of feeding.**

	Lot 1 Full feed of corn	Lot 2 Three-fourths full feed	Lot 3 One-half full feed
Average daily feed per steer:			
Corn and cob meal..................pounds..	13.3	10.1	6.7
Protein supplement..................do....	1.5	1.5	1.5
Silage..................do....	13.7	14.1	14.2
Legume hay..................do....	3.2	6.2	8.7
Average daily gain in weight..............do....	1.91	1.78	1.69
Average acreage of feed crops per lot of 12 steers acres..	15.24	14.76	13.86
Average gains of the cattle per acre of feed crops pounds**.	387	369	368

* The steers averaged 691 pounds per head and were fed for an average of 240 days. Each lot contained 12 steers for each of 3 consecutive feeding periods, beginning in the fall of 1935.

** The gains of hogs following the cattle to pick up waste feed are included in each lot. The gains of the hogs per acre were 26, 20, and 14 pounds for lots 1, 2, and 3, respectively.

[1] Head, pasture section, agronomy division, Soil Conservation Service, Washington, D. C

[2] The Bimonthly Bulletin, May-June, 1939. Ohio Agricultural Experiment Station, Wooster, Ohio.

Loading hay on a contour strip in eastern Iowa. If the soil is to be adequately protected from erosion, if its productivity is to be maintained or improved, and if people and property in river bottoms are to be protected from floods, crop rotations must provide for having cropland in perennial grass and other erosion-resisting and soil-building vegetation a considerable part of the time.

Decreasing the corn and cobmeal from 13.3 pounds daily to 10.1 pounds daily and increasing the legume hay from 3.2 to 6.2 pounds per head daily cut the daily gain from 1.91 to 1.78 pounds, but did not affect the selling price per 100 pounds of the live cattle or adversely affect the color of the carcasses. On the heavier grain feed, the cattle and hogs gained 387 pounds per acre of land producing the feeds. On the lighter grain ration the cattle and the hogs gained 369 pounds per acre.

The average of 3 years' work with a third lot of yearling steers, fed 6.7 pounds of corn and cobmeal and 8.7 pounds of legume hay in addition to the protein supplement and silage, averaged 1.69 pounds gain per day. The average gain per acre of land used in producing feed was 368 pounds. These steers, getting a light feed of grain and correspondingly heavy feed of hay, sold for about 6 percent less per hundredweight. There was no appreciably adverse condition in the color of their fat.

Feeding the cattle the heavy grain ration required 5½ acres of corn for each acre of hay. The medium grain feeding required 2.3 acres of corn to 1 acre of hay, while the cattle receiving a light feed of grain consumed 1.2 acres of corn for each acre of hay consumed. These figures take into account the corn used for silage as well as grain in each case.

The relatively good showing in gains per acre, of the cattle getting the light grain ration, indicates the possibilities of keeping a large proportion of the farm in perennial meadow, using the hay to feed steers and getting them fat enough to meet the demands of the beef trade. It should be kept in mind that in fattening beef calves a higher proportion of grain to hay is necessary than in fattening yearlings. An excellent 4-year rotation of crops for soil-building purposes in the Corn Belt consists of 1 year of corn, followed by small grain, and 2 years of clover and perennial grass. All of the grain, hay, straw, stover silage, and pasturage produced by such a rotation of crops may be used economically by beef cattle. Obviously, all farmers are not interested in producing beef cattle exclusively, but there are many other possibilities for using to advantage a relatively large acreage of hay in feeding livestock. I think we should mark up another score for grassland farming.

All of this is an excellent sequel to and fits in very nicely with the comparison of livestock and grain systems of farming which was started by the Ohio Agricultural Experiment Station at Wooster in 1910.[3] In each system, a crop rotation of corn, soybeans, wheat, and red clover was used for the first 20 years. Then sweetclover was substituted for red clover. In the livestock rotation, all the manure produced in feeding the crops, excepting the wheat, was returned to the land with practically no waste. In the grain system, no hay was made and all the crop residues were left on, or returned to, the land. The land in both systems has had the same soil amendments including limestone, 320 pounds of 20-percent superphosphate applied each

[3] Progress of Agricultural Research in Ohio, 1936-37. Bulletin 592. Ohio Agricultural Experiment Station, pp. 24-26.

A beef breeding herd on winter range in eastern Wyoming. Such ranges produce more cattle and sheep than can be fattened on the feeds raised in the West. Livestock therefore is shipped to the Corn Belt and the East, where more feed is produced than the local livestock can use. Adequate protection of the soil will help to maintain this important relationship.

time the land is in corn, and 240 pounds of 20-percent superphosphate preceding each wheat crop. In addition, in the livestock system, manure has been spread on the land each fourth year, when it is in corn, at the rate of 2.28 tons per acre.

A comparison of crop yields per acre, in livestock and grain farming, at the Ohio Agricultural Experiment Station at Wooster, 1910–36

	First 10-year period	Second 10-year period	20-year average	7-year average 1930–36
Ear corn:				
Livestock farming..........bushels..	67.3	86.3	76.8	70.0
Grain farming..............do....	59.2	79.8	69.5	* 69.2
Difference................do....	8.1	6.5	7.3	.8
Soybeans:				
Livestock farming...........do....	21.7	25.1	23.4	27.7
Grain farming..............do....	19.1	22.0	20.5	26.8
Difference.............. ..do....	2.6	3.1	2.9	.9
Wheat:				
Livestock farming...........do....	32.5	33.8	33.1	36.1
Grain farming..............do....	29.4	29.7	29.6	29.3
Difference...............do....	3.1	4.1	3.5	6.8
Clover hay: Livestock farming.....tons..	2.24	2.68	2.46	2.08

* There were two very poor corn crops in the last 7 years.

These data show striking differences in favor of livestock farming and indicate that livestock farming is a more effective method of maintaining and improving soil fertility than grain farming, provided all the manure is carefully saved and applied to the land. While in each system of farming equal quantities of lime and phosphates were being applied, the land in the livestock system actually received greater accretions of fertilizing materials than that in the grain system. The grain land lost all the fertilizing elements in the grain, including the corn, wheat, and soybeans which were harvested, while the livestock land lost about a fifth of the fertilizing elements in the corn and soybeans and other roughages, principally hay, which were consumed by livestock. The losses in the case of the wheat were the same in either case, and there were no appreciable losses in the roughage used for bedding.

Livestock on the average farm excrete about 80 percent of the nitrogen and other fertilizing elements contained in the feed they eat.[4] Cows and other female stock when they are pregnant or giving milk, and young growing stock, excrete a smaller percentage of the nitrogen phosphorus and potassium contained in their feed, while mature and fattening stock excrete a larger percentage of these elements. Naturally, the building of bone and muscle and the secretion of milk make it necessary for the animals to remove from their feed more of the fertilizing elements in the form of various proteins and minerals than is necessary for fattening, maintenance, farm work, or other draft purposes. Very young calves and lambs may store two-thirds of the nitrogen and minerals in their feed. Two-year-old steers being fattened may excrete as much as 87 percent of the nitrogen and phosphorus they consume.[5]

Failure to take satisfactory care of manure is a common weakness in livestock farming as it is generally practiced. Unless manure is properly handled, it will lose fully one-half of its value for crop production before it reaches the land. Proper handling consists of such practices as adding 30 pounds of superphosphate per ton of manure to guard against losses of nitrogen in the form of ammonia, using enough litter to absorb the liquids, tramping to prevent fermentation and loss of ammonia, keeping under cover by means of water-tight flooring, and spreading evenly on

(*Continued on p. 72*)

[4] F. B. Morrison: Feeds and Feeding. Twentieth edition (1937), p. 413.

[5] Grindley, Mumford, Emmett, and Bull: Illinois Agricultural Experiment Station Bulletin 209.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE ROLE OF PLANT LIFE IN THE HISTORY OF DUTCHESS COUNTY. By Edith Adelaide Roberts and Helen Wilkinson Reynolds. Vassar College. 1938.

Carefully compiled ecological studies supported by historical findings are welcome to a Service whose chief interest is reclamation and protection of the soil—the Soil Conservation Service. The first author is on the staff of the Department of Botany at Vassar, and the second is a member of the Dutchess County Historical Society. The two have worked well together to produce a monograph that identifies all the vegetation of their county and to show clearly the historical use of the land and its results in relation to the future.

The reviewer has been informed by the authors that their monograph will be used for supplementary study in erosion-control education at Vassar. It is reviewed here because it should prove valuable in a conservation education program anywhere. Its pattern is closely defined from an ecological standpoint, and the many interesting and intimate stories of Indian occupation and sawmill and gristmill days, and of trees and shrubs, herbs and grasses fighting for life from bog to upland, all emphasize the urgent importance of an understanding of environmental conditions for plant life as protection for the soil.

The study opens with an excellent description of the development of plant life under present conditions on the uplands and in the lowlands of Dutchess County lying on the east bank of the Hudson, in the middle part of the valley, between Red Hook and Fishkill. The numerous observation notations—of an old oak here, an herb there, an aquatic on the edge of a young stream—show that the authors tramped many a mile over their county to establish environmental factors before compiling their data into an account of the succession of associations. The climax plant formation of the area is the beech-maple-hemlock association; and the story as told here, of plant associations—open field, lake and pond, bog, river and stream, ravine—as they climb toward this goal (or would climb, given the opportunity) is much more comprehensible and informative, to the beginning as well as the trained ecologist, than is a volume on general ecology.

The geologic past of the area, with the vegetation of the periods, is sketched briefly. Some inaccuracy is found here, possibly editorial or typographical, but an accompanying geological map (after Robert Black) gives an idea of the age of the area formations and is interesting when used in conjunction with the remarkable aerial map from the cover pockets. This map, in two very large sheets of excellent quality paper, is indeed an innovation in vegetation studies.

Soil, land moisture, precipitation, light, and temperature are treated from the standpoint of plant growth and adaptation. Here is the indication that water retention of the soil has lessened with the cutting down of the forests during the past two or three hundred years.

The device of Indian place-names is employed rather effectively to show how the Red Man used the vegetation of Dutchess County. From the known facts concerning the tribes who occupied the area, the authors infer " . . . that the Indians appreciated fertile soil, that they had an occasional clearing or field where they raised corn, beans, squash, and tobacco, that they cultivated fruit trees, and that in general, they cleared only the timber along the stream sides." A map of Indian encampments goes with this part of the monograph.

The section which tells of the white man's relationship to plant life in this once completely forested area is a thorough piece of work and is also important historically. Mills—sawmills that the trees from advanced associations might become "fine Dutch barns" or handsome panelling for chimney-breasts and cupboards, or clapboards and shingles, and gristmills to grind the grain raised on the land shorn, a little at a time, of its forest—mills had a great deal to do with exploitation by the white man. As it happened, between the 1680's when the first mill was built by Madame Brett in the Rombout Patent, and 1867 when mills numbered 113, the original vegetation had disappeared except for a lonely old beech here, a group of silver maples there, an ancient tulip tree guarding a ruined stone foundation. (A sketch map of the county in its modern form, showing the old trees, is included.) By 1880, 95 percent of the land area of Dutchess County had been converted by the white man into farms—and then came the recession.

The soil, robbed of its protection, could not endure. By 1930, but 65 percent of the land was in farms; the 45 percent dropped from cultivation is today slowly working its way climax-ward. The Juniper and Gray Birch Associations are seen on some of the uplands, and the Shrub Association of scrub oak appears where land many times burnt-over is now protected. As to the swamp areas, the authors suggest that they should perhaps be allowed to return to the Oak Association: "In the more advanced swamps plantings of red oak, white oak, and hickory could be made and the lowland succession speeded up and made more use of . . . The mosquitoes would be reduced by such planting and the water level would be maintained . . . A permanent water supply may be conserved in this way and the land is not needed for cultivation. This applies to the entire county."

Plant life in the future development of Dutchess County, New York State, is emphasized in a final secton of the monograph. And, briefly, we are told of the plan to establish the Dutchess County Outdoor Ecological Laboratory, under the Department of Botany of Vassar College, ". . . to make possible the fullest utilization of the plant life . . . through a complete knowledge of the individual plants of each of the associations." It is to be a "plant use" laboratory, its chief objective the supplying of information concerning production and aesthetic and economic uses of all the plant members of the area's associations. Some sample planting lists are included along with an interesting sketch of home-site arrangement.

Finally, the study presents an alphabetical list, by botanical nomenclature according to Gray, of herbs, trees, ferns, and shrubs belonging to the various plant associations of the county. There are 1,055 plants listed, and common names are given for the amateur—and for the delight of the philologist with special bent toward the romance of words!

An 88-item bibliography includes works on ecology, botany, Indian geographical names, soils, doorways and period work in woods, daily light periods for plant growth, and many other subjects into which the authors of this monograph delved for a thorough understanding of the future needs of the land of their county as well as its primeval conditions and its early history.

A WORLD TOUR FOR THE STUDY OF SOIL EROSION CONTROL METHODS. By A. Grasovsky. Institute Paper No. 14, Imperial Forestry Institute, Oxford, England. 1938.

A year or so ago the chief forester of Palestine, Dr. A. Grasovsky, came to this country to study soil conservation and reforestation practices as carried out in the Middle and Western States—those areas with problems similar to his own in the ancient country bordering the eastern Mediterranean. Naturally his chief interest was cover for desiccated land, for the control of erosion and to build up forest soil. As he had already visited the Sahara and had studied anti-desiccation work in Nigeria, reforestation methods in Algeria, and sand dune fixation in Morocco he was well equipped to judge with an appraising mind what he observed of soil conservation work in Colorado, New Mexico, and Arizona, Utah and Texas, and in forest experimental stations farther east. From this country he went to the Far East and returned to Palestine via Japan, Java,

BOOK REVIEWS AND ABSTRACTS continued

Malaya, Ceylon, and India. His report, called "A World Tour for the Study of Soil Erosion Control Methods," is most illuminating; it displays a cosmopolitan basis for understanding and for presenting the findings in a way that adds much to their value for the author's American associates. The discussion of American methods is trenchant and substantial, in places frankly critical, but at the same time gives due weight to erosion-control activities as "bound to be of benefit to the country generally, and . . . of great importance as a new departure."

It is especially interesting to learn just what practices and experiments in what areas of the United States appeal strongly to the chief forester of Palestine. The work of our Service in Navajo land he calls "a most interesting soil conservation undertaking" and points out pasturage improving, water spreading, fruit tree planting, ravine-bed stabilizing, and livestock exchange—better breeds and fewer animals—in the 16 million acres of desert-border land as showing "how much can be done with semiarid areas if they are properly and intelligently managed." In the Middle West, Dr. Grasovsky's attention was arrested by windbreak and woodlot planting of the Service on farms requiring protection from wind erosion. Of the Rio Grande project where he found much to interest him, he sums up his observations thus: "The chief significance of the work lies in the fact that all operations in the territory are organized by one department which, having studied all the details, and taken into consideration all the various interests involved, develops comprehensive schemes, each covering a whole water-catchment area. The purpose of this unification of control goes far beyond the mere management of a few demonstration plots: the ultimate aim is to secure properly planned utilization of the whole vast and complex area."

Dr. Grasovsky points out that in his opinion much of the erosion-control experimental work is still concerned with demonstrating on specific areas facts which have long been scientifically established, with the object of arousing the interest and sympathy of the American public in erosion control. "Nevertheless," he adds, "all who are interested in erosion and desiccation problems should be gratified that, at long last, these problems are now occupying the minds of the American people, who are perhaps preeminently in a position to devote the necessary time and money to their solution, and to the eventual discovery of ideal methods of control."

In his chapters on African desert regions, Dr. Grasovsky gives an interesting description of the middle Sahara. He tells of water courses lost in sand, of oases, meager vegetation and animal life, the great central plateau, lofty mountains and no evidence of flowing rivers. In the near-Nigeria area, which had been denuded by over-use, complete recovery was seen, and there were also local indications that vegetation is invading the desert rather than that desiccation is spreading outward. In Algeria, revegetation was the only method of erosion control being used: Allepo pine, cedars, cypress, cork oak were planted on badly denuded slopes; black locust in ravines; eucalyptus on river banks and newly formed alluvial flats.

While in the United States, Dr. Grasovsky visited the Appalachian Forest Experiment Station, the Lake States Stations at La Crosse and Huron, the California Forest and Range Station on the Sierra Madre Mountain range, and the Desert Range Experiment Station at Milford, Utah. He presents significant findings at these stations with considerable detail. It is apparent throughout his discussions that his chief concern while on world tour was to discover soil and water conservation methods that would be adaptable to arid Palestine. His report is receiving considerable attention among thoughtful conservationists in this country.

ACREAGE OF HAY

(Continued from p. 70)

the fields in as fresh a condition as practicable. Letting the manure accumulate in open lots, and under the eaves of barns without spouts, is the worst kind of treatment, as rainwater may leach out fully half of the plant food contained in the fresh manure. If open lots must be used, the smaller the better, provided the stock have room to stand in the sun in the winter and in the shade in the summer.

The mere fact that a farmer is feeding all of his crops to livestock or that he is buying feed from his neighbors does not prove that he is maintaining the productivity of his fields and pastures. As a result of failing to save the organic matter and soluble nutrients in the manure, the livestock farmer may actually be depleting his farm more rapidly and allowing erosion to proceed more rapidly than his neighbor who is practicing grain farming and seeing that all crop residues are returned to the soil and used as cover and as a source of organic matter. In either system, with no significant losses of soil by erosion, soil amendments such as limestone phosphates and potash are necessary to replace the minerals which are removed from the farm by the sale of grain, livestock, and milk.

CROP AND TILLAGE ROTATION

(Continued from p. 65)

especially important where vegetative protection provides insufficient control of erosion.

In wind erosion areas utilization of crop residues begins at harvest. The straw scatterer distributes cut straw uniformly over the stubble where it may be handled to provide a surface mulch if later tillage is modified for this purpose. Subsequent tillage with the lister bottom, the modified moldboard plow or the one-way disk has been successful in obtaining this result. When the one-way disk is used, one disking is considered sufficient.

Fallow operations with the rod weeder are favored because of the effectiveness of the implement in weed suppression, and because in operation it disturbs only a shallow layer of soil, thus preserving a maximum amount of soil moisture. The rod weeder also assists in preserving a trashy surface. If the disk drill is used, seedbed preparation for fall wheat may not require an additional tillage step.

In heavy stubble, frequently encountered where annual rainfall is more than 16 inches, fall disking is required as a means of assisting in decomposition and reduction of stubble.

U. S. GOVERNMENT PRINTING OFFICE: 1939

Bulletins of Wide Interest Feature Cover Crops and Farming Practices

For REFERENCE Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field Offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information, U. S. Department of Agriculture

The Black Hills Beetle: A Serious Enemy of Rocky Mountain Pines. Farmers' Bulletin 1824. Bureau of Entomology and Plant Quarantine. July 1939.

A Chemical Study of Some Soils Derived from Limestone. Technical Bulletin 678. Bureau of Chemistry and Soils. June 1939.

Effects of Fire and Cattle Grazing on Longleaf Pine Lands as Studied at McNeill, Mississippi. Technical Bulletin 683. Forest Service, Bureau of Animal Industry, and Bureau of Plant Industry. June 1939.

Reseeding Range Lands of the Intermountain Region. Farmers' Bulletin 1823. Forest Service. July 1939.

Sand-Dune Reclamation in the Southern Great Plains. Farmers' Bulletin 1825. Soil Conservation Service. August 1939.

Soil Conservation Survey Handbook. Miscellaneous Publication 352. Soil Conservation Service. August 1939. 20¢.[1]

Soil Defense of Range and Farm Lands in the Southwest. Miscellaneous Publication 338. Soil Conservation Service. June 1939.

Weather and Plant-Development Data as Determinants of Grazing Periods on Mountain Range. Technical Bulletin 686. Forest Service. May 1939.

Agricultural Experiment Stations

Basic Trends of Social Change in South Dakota. I. Population Tendencies. Bulletin 327. Agricultural Experiment Station, Brookings, S. D., in cooperation with Works Progress Administration. April 1939.

Certain Economic Aspects of Agriculture in the Jackson County Soil-Conservation Area. Bulletin 291. Agricultural Experiment Station, Morgantown, W. Va. July 1939.

Chemical Characteristics of the Soils of the Rice Area of Louisiana. Louisiana Bulletin 307. Agricultural Experiment Station, University, La. March 1939.

Climatic Conditions and Suggested Cropping Systems for Northwestern Oklahoma. Experiment Station Circular 83. Agricultural Experiment Station, Stillwater, Okla. June 1939.

Conserving Soil by Contour Farming. Circular 399 (Revision of Circular 365). Agricultural Extension Service, Columbia, Mo. February 1939.

Control of Crop Nutrition by the Method of Foliar Diagnosis. Bulletin 378. Agricultural Experiment Station, State College, Pa. April 1939.

Effect of Degree of Base Saturation of Soils upon the Fixation of Phosphate and Potassium and the Availability of Phosphorus. Bulletin 215, Technical No. 22. Agricultural Experiment Station, Newark, Del. October 1938.

Effect of Soil Type, Slope, and Surface Conditions on Intake of Water. Research Bulletin 112. Agricultural Experiment Station, Lincoln, Nebr. May 1939.

The Farmer Looks at Soil Conservation in Southern Iowa. Bulletin 381. Agricultural Experiment Station, Ames, Iowa, in cooperation with Soil Conservation Service, U. S. Department of Agriculture. June 1939.

Farming Possibilities in Horry County, S. C. Bulletin 318. Agricultural Experiment Station, Clemson, S. C., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. May 1939.

Farm Practices and Management in Central Pennsylvania. Bulletin 379. Agricultural Experiment Station, State College, Pa. May 1939.

Grass Silage: Its Place in Agriculture, How to Make It, How to Feed It, What Grass Silage Is. Cornell Extension Bulletin 409. Cornell Agricultural Experiment Station, Ithaca, N. Y. May 1939.

Ohio Agricultural Statistics, 1937. Agricultural Experiment Station, Wooster, Ohio, in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. Bulletin 602. March 1939.

Pasture Plants and Combinations. Extension Bulletin 197. Agricultural Extension Division, St. Paul, Minn. March 1939.

Planting the Standard Windbreak. Extension Bulletin 196. Agricultural Extension Division, St. Paul, Minn. March 1939.

Poisonous Plants and Livestock Poisoning. Bulletin 231. Agricultural Experiment Station, Laramie, Wyo. May 1939.

Report of the Hawaii Agricultural Experiment Station, 1938. Hawaii Agricultural Experiment Station, Honolulu, Hawaii. May 1939.

The Soil Characteristics of Connecticut Land Types. Bulletin 423. Agricultural Experiment Station, New Haven, Conn. May 1939.

The Soils of Florida. Bulletin 334. Agricultural Experiment Station, Gainesville, Fla. May 1939.

Soybeans—their effect on soil productivity. Bulletin 456. Agricultural Experiment Station, Urbana, Ill. June 1939.

Miscellaneous

Regional Research Laboratories, Department of Agriculture. (Letter from the Secretary of Agriculture transmitting a Report of a Survey made by the Department of Agriculture relative to Four Regional Research Laboratories—one in each major farm producing area.) Senate Document No. 65, 76th Cong., 1st ses. 1939.

Restoration Land and Wind-Erosion Area: 1939 Agricultural Conservation Program—North Central Region. North Central Division, Agricultural Adjustment Administration, U. S. Department of Agriculture. NCR-301-RL, Revised. June 1939.

Roadside Erosion Institute, Proceedings. Bulletin 6. State Soil Conservation Committee in cooperation with Rutgers University, New Brunswick, N. J. June 1939.

Soil Saving on General Dairy Farms in New Jersey. Bulletin 5. State Soil Conservation Committee, New Brunswick, N. J. April 1939.

A Study of Farming in the Gilmore Creek Soil Conservation Demonstration Area, Winona County, Minn.—Some Implications of the Recommended Soil and Water Conservation Program. Soil Conservation Service and Bureau of Agricultural Economics in cooperation with Agricultural Experiment Station, St. Paul, Minn. June 1939. mm.

Trees and Shrubs as Soil Savers. Bulletin 4. State Soil Conservation Committee, New Brunswick, N. J. February 1939.

[1] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

WINTER GRAZING OF PASTURE

must be carefully controlled because

DAMAGED SOD INCREASES EROSION

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

In This Issue ~ Farm Ponds in Soil and Moisture Conservation

1939

OCTOBER

CONTENTS

Front cover by Adrian Clem
Back cover by C. E. Margraff

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 4 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON OCT. • 1939

SOME ECONOMIC AND SOCIAL PROBLEMS OF SOIL CONSERVATION

By ARTHUR C. BUNCE [1]

THE PROBLEMS of soil conservation, as seen from an economic and social point of view, may be summarized in four rather broad statements: (1) We need to know when exploitation becomes uneconomic, and the factors that determine the level whereon conservation becomes economic for both the individual and society. (2) We need to know also the social and economic factors which cause exploitation to continue after conservation has become economic. (3) After we have analyzed the causes of exploitation, we need to evaluate the various methods of inducing conservation so that those most applicable may be used in a given situation. (4) Once a particular program is set up, we need to know whether it has achieved its objective of controlling erosion and whether it is an acceptable and economic program from the individual farmer's point of view.

All these four general problems impinge upon the individual farm, and all have wider implications of a regional and social character which may help to determine the specific plan for adoption and the social philosophy upon which a program of control or planning may be justified. The objective of this article is to outline some of the findings of a recent study of the soil conservation program on individual farms in Iowa.[2] While the bulletin reporting the study deals largely with the effect of the program, the first three problems are discussed here in order to show the close inter-relationship of all four.

[1] Dr. Bunce is assistant professor at Iowa State College and cooperative agent of the economic research division of the Soil Conservation Service.

[2] Arthur C. Bunce. The Farmer Looks at Soil Conservation in Southern Iowa. Bulletin 381. Iowa Agricultural Experiment Station, June 1939.

Factors Determining the Point Where Conservation Becomes Economic

Under perfect competition, given such basic assumptions as complete mobility and divisibility of the factors of production, perfect knowledge and the "economic man," there would be no such phenomenon as the uneconomic exploitation of resources. Neither would there be any conflict between the social and individual point of view, since such conflicts arise only when social groups or agencies have greater knowledge than the individual and can, therefore, make wiser decisions or eliminate certain risks and uncertainties. Given perfect competition, the maximum social and individual productivity will result from the interplay of competitive forces at the margins. When land is plentiful and cheap, relative to labor and capital, it will be used extensively and very little effort or cost can be expended to conserve it. But as labor and capital become more plentiful and land relatively scarce, then more labor and capital are combined with land in a given area and conservation automatically becomes economic.

In the early days of the development of the United States, when land was very abundant, it was "economic" to exploit the land and invest capital in commerce, industry, and education. Out of this early exploitation we built our cities and industrial plants. As population increased and our agricultural land was taken up, land values rose, interest rates declined, and yet exploitation continued although conservation became more and more economic. In a given situation, the major factors that determine the level whereon conservation becomes economic are the interest

178818—39——1

rate, the rate at which exploitation is depleting the capital assets, and the increasing cost of maintaining or restoring them as erosion becomes accelerated.

In a dynamic economy of changing population, changing techniques of production and transportation, changing consumer demand and flexible prices, the individual is not able to anticipate the future with certainty. This uncertainty may lead to a conflict between the individual, to whom exploitation appears to be economic, and society which because of broader interests sees that the present values forming the basis of the individual's judgment do not adequately represent the future. Such a situation is sometimes referred to as a conflict between individual time preference and social time preference, but this is merely a rather indefinite way of stating that society, because of its broader interests, is better able to anticipate the uncertainties of the future.

In order to discover whether an area has reached the point where soil conservation is economic we would have to estimate the annual rate of *capital loss* due to erosion, the *costs* of achieving erosion control, and the *effect* of the control measures upon current income for a sample of the various types of farms found in the area. While this has not been done in the study reported, the general indications are that in the southern part of Iowa participation in the soil conservation program has been economic. For example, 55 percent of 310 farmers stated that the conservation program had increased the productivity of their farms, and over 90 percent stated that they expected the productivity of their farms to be increased in the next few years. Seventy-eight percent reported that the program had increased the value of their farms, and according to the estimates made by 172 of the farmers, this amounted to an average increase of $5.44 per acre. In interpreting these figures, the fact that assistance was given in obtaining lime and fertilizer must be kept in mind.

This study also indicates the relationship between the degree of erosion and the costs of control. Under the Soil Conservation Service program, permanent pasture on cooperating farms is to be increased by about 10 percent in the western livestock and south-central pasture areas of Iowa, and intertilled crops are reduced about 11 percent. In the southern pasture area, permanent pasture is being increased by 23 percent and intertilled crops reduced 39 percent. Similarly in the case of structures, wide differences between the areas are reported. The southern pasture area, for example, has larger acreages of the cropland terraced and has more temporary and permanent dams erected than in the other two areas. As for contour farming and strip cropping, however, the southern pasture area has a smaller acreage per farm than have the other two areas.

These differences in the program, in adjoining areas in one State, reveal clearly the fact that conservation planning varies widely as physical conditions vary. Even within one watershed wide differences between the treatment of individual farms is noticeable. In the case of the areas mentioned above, the southern pasture area has more serious sheet erosion and more gullying than have the western livestock and south-central pasture areas, and the analysis indicates that in areas where erosion has made greater progress the cost of control in terms of structures involving capital outlays is larger and the changes in land use are more drastic.

In some areas in Iowa only relatively small changes in land use, coupled with such practices as contour cultivation and strip cropping, may be sufficient to stabilize soil fertility; in other areas terracing, retirement of cropland to pasture, and longer rotations may be needed, together with still other conservation practices, in order to achieve control. This seems to emphasize the fact that we need an economic appraisal of every suggested plan for soil conservation on an individual farm or area in order to determine whether or not conservation is economic. If this is not done, we may be allocating our capital to the creation of resources which are not the most economically productive, and the same amount of money expended on other areas or on other types of resources might achieve more conservation of more productive resources.

Causes of Continued Exploitation

If conservation becomes economic as population and capital increase, we are faced with the problem of determining the factors which prevent an automatic adjustment from taking place. An analysis of the basic assumptions underlying perfect competition reveals some of the economic and social problems associated with soil conservation.

We find that in agriculture we do not have complete mobility, because a rural population develops a degree of fixity in its regional patterns and its attachments to familiar scenes. Similarly, perfect divisibility of factors is not possible, since farm sizes tend to become associated with certain typical types of enterprise and density of population. As to knowledge, we find that the majority of farmers are not aware of alternative uses for the resources, and they tend to follow a

customary method of farming. Finally, the farm unit is not purely a place of business but is also a home, and therefore considerations other than the purely economic play an important part in making decisions.

One of the causes of these rigidities is that certain institutional patterns developed during the period when exploitation was economic. For example, a type of tenure relationship may evolve, market outlets for particular products may be established, taxes for roads and schools and other public services become fixed charges, and rather stable farm units become associated with the farm buildings. Under the exploitive system these may be efficient; but as the virgin fertility is used up and erosion develops, they may act as resistances to the necessary adjustments.

Another important factor tending to prevent adjustment and the shift to a conservation system of farming may be the mistakes of the past in permitting or encouraging a type of land use which is not permanently adapted to the climatic and soil conditions of the region. For example, the use of much of the Great Plains region for arable farming has led to the present population and farm-size pattern, with the development of roads and schools, present land values and taxes, and marketing facilities for cash grain crops. In these circumstances the present institutional set-up may make it impossible for an individual to adopt conservation measures because of the costs to be incurred and changes involved, although the adjustments might be economic were there greater flexibility.

A further important factor which must be considered is the question of whether or not the individual farmer is suffering all the damages of exploitation, or whether certain of these damages are borne by other individuals or groups. Where the latter occurs, as in flood damages, the silting of rivers, reservoirs, and lowlands, or where gullies and run-off damage adjacent lands, then continued exploitation may be economic for an individual only because he does not bear all the disadvantages and damages.

These causes of continued exploitation vary greatly between regions, States, areas within a State, and even between farms in a given area. In some areas the tenure system may be the most important resistance; in others it may be farm size, and again it may be ignorance or inertia. Only as we discover what these resistances are can we apply the most strategic methods of inducing conservation.

In Iowa the tenure system, with its resulting insecurity of occupancy, and the mortgage problem have been shown to be important social factors resisting the adoption of a more permanent system of farming.[3]

The present study reveals that farmers in southern Iowa have recognized the menace of erosion for many years. Over 50 percent of the farmers cooperating with the Soil Conservation Service had noticed erosion on their farms over 15 years ago, and 27 percent had noticed it 6 to 15 years ago. Of a similar group of farmers not cooperating, 47 percent had noticed erosion over 15 years ago. In their attempts to control it, many had adopted rotations more suited to the topography of the land; some had put brush, straw, and manure in gullies and had established grassed waterways. Fifteen percent had good results in controlling gullying. The reasons given why they did not do more were: "cost prohibitive," "did not know how," "tried but failed," "did not get around to it," and "did not know how long would be on the farm."

This throws some light on the problem of analyzing these basic causes. We find lack of capital for financing changes, lack of knowledge, past failures, inertia, and insecurity. If these are important in one of the richest of our agricultural States, then they may be even more important in other areas where more insecurity and less financial reserve are dominant. The problem of conservation appears to be linked closely to the problems of farm credit, tenure, and education.

Inducing Soil Conservation

Where there are many basic causes of soil exploitation, there are numerous methods that can be used to offset them. These may be briefly classified as follows: (1) Education by means of demonstration projects, Extension Service activities, high school and college classes, and publicity releases of all kinds; (2) direct subsidies to help defray the cost of actual conservation measures; (3) indirect subsidies, such as free services of technicians for planning farms, special rates of interest on loans for conservation expenditures, tax rebates, low-cost lime, fertilizer and seed, and subsidized prices for special products; (4) laws affecting the resistances, by modifying the social conditions, such as tenure, resettlement, and educational legislation; (5) laws permitting local group action, as zoning ordinances or conservation district acts; (6) laws limiting the property rights of individuals in land, such as some zoning acts and specific regulatory acts to prevent abuses which are harmful to society; and (7) public ownership.

While the list given above is not complete, it does

[3] See Schickele, Himmel, and Hurd: Economic Phases of Erosion Control in Southern Iowa and Northern Missouri. Bulletin 333. Also see Schickele and Himmel: Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area. Research Bulletin 241. Iowa Agricultural Experiment Station.

serve to outline the large number of alternative and supplementary methods that may be used to induce conservation or control land use. Practically all are being used today, singly or in combination, by various Government agencies at different levels; and herein we find a major difficulty in the evaluation of any particular program, because not only must we estimate the program's effectiveness in meeting the basic economic and social causes of the condition we are trying to remedy, but we must also attempt to disentangle its influence from the influence of other programs which also impinge upon the problem.

For example, an important factor to be considered, when evaluating the amount of change in land use introduced by the Soil Conservation Service, is the change in land use that has taken place, on farms not cooperating in the program, because of the influence of factors other than the Service program. In the study here discussed a sample of farms not cooperating with the Soil Conservation Service was taken and the changes in land use from 1933 to 1937 were tabulated. This showed that on noncooperating farms permanent pasture had been changed very little, intertilled crops had been decreased, small grains increased, and total meadow decreased. In all areas, however, the changes in land use towards a soil-conserving system were much greater on the farms cooperating with the Service than on those not cooperating.

We should know how important these other factors have been in assisting the farmers cooperating with the Soil Conservation Service to make the needed reductions in the acreage of intertilled crops, since obviously the final effect is the result of their concurrent action. To evaluate this situation objectively appears impossible at this time. Further study certainly should be given problems such as these in order that farmers and State and Federal workers may make effective decisions.

Difficult as this problem is, it appears essential that some attempt be made to evaluate the effectiveness of all control measures in terms of their ability to affect the basic social and economic causes underlying erosion. This evaluation can be made only as we obtain more insight into the causes, the methods that may be used, their costs to society, their acceptability and their effectiveness as they are applied to relatively small areas and on individual farms.

Program in Southern Iowa

Any conservation program that is established in any particular area must satisfy two basic requirements if it is to be permanent and widely adopted over the areas where conservation is needed: It must control erosion effectively, and it must be acceptable to the farmer. To be acceptable, when no subsidy is paid, means that it must be economic from the individual operator's point of view. Again, farmers' opinions must be given an important place because it is what the farmers think of the program, and specific elements in it, that will finally determine how much of it becomes permanent and whether or not it will spread to farms outside the demonstration areas.

As to the effect of the program upon erosion, over 90 percent of the farmers report that it has been effective in reducing both gully and sheet erosion. The accompanying table gives a summary of their opinions:

Table showing opinions (by percentage of farmers reporting) regarding the effect of the program on erosion conditions in southern Iowa, 1937. Sheet erosion was reported on by 290 farmers; gully erosion, by 284 farmers.

Types of erosion	Stopped	Greatly reduced	Slightly reduced	Not reduced	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Sheet erosion	4	51	36	9	100
Gully erosion	11	58	24	7	100

This indicates that in southern Iowa the program has been quite successful in controlling erosion, according to the present opinions of the cooperating farmers. It will be interesting to learn whether the same farmers on the same farms will have the same opinions 5 years from now.

When we turn to the second question, of whether or not the program has been acceptable to the farmer, we find a much more complicated problem, with parts of the program satisfactory to all and some elements in it satisfactory. The economic effects are related to the changes in land use and the resulting repercussion on yields, the relationship of grain to roughage feeds, the livestock system, and the total and monthly labor quantities used. Only a few of the most important results can be presented here.

As was indicated previously, the farmers stated that the program had increased the productivity of their farms, and they seem to have been well satisfied with it in spite of the fact that they listed numerous specific difficulties resulting from farming terraced, strip-cropped or contoured fields. In general, the farmers would continue all the present practices and the land-use patterns introduced, without further assistance from the Soil Conservation Service, with the exception of strip cropping which would be discontinued by 27 percent of the farmers, and contour farming which would be discontinued by 15 percent of the farmers.

(*Continued on p. 82*)

An excavated reservoir in process of construction. The dragline is being used extensively for making dugouts. Dugouts are well suited to relatively flat terrain.

FARM PONDS IN SOIL AND MOISTURE CONSERVATION

By H. G. JEPSON [1]

THE use of ponds to supplement water supplies on the farm or ranch is by no means new. Probably the practice is centuries old. In the United States ponds have been in use as long as farming has been carried on. The increased need for this source of water supply, however, has become most apparent of late years, especially since the drought periods occurring since 1929. If an annual rainfall of 85 percent of the mean is considered as producing drought conditions, then there have been 11 major drought years in the period from 1881 to 1936; of these 11 a total of 5 occurred since 1929, namely, 1930, 1931, 1933, 1934, and 1936. In 1936 a total of 18 States recorded drought conditions, some of them extreme.

It is when several drought periods occur in close succession that water supplies dwindle. Sources that for many years had been unfailing went dry during and immediately following these repeated dry periods. This was especially true of springs, small streams, and shallow wells. In certain localities the only available water was from a few well-designed ponds or reservoirs where the impounded supplies were adequate to withstand evaporation and seepage.

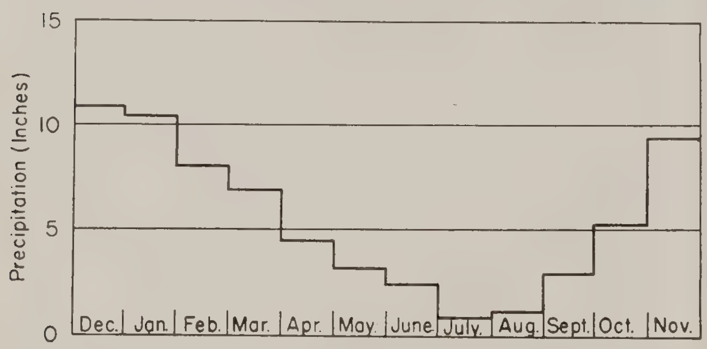
When other sources of water supply fail, the farm pond is almost indispensable. Not only is it used for livestock watering but also for domestic purposes to supplement erratic wells or the cistern—although when used in the household it is, of course, necessary to install measures to insure purity and safety. Ponds also may be used for irrigations, for recreational facilities such as boating or swimming, for wildlife such as game birds and fish, and in northern climates as a source of ice. Of the farmers and ranchers fortunate enough to have good farm ponds during the recent droughts, many when questioned declared that they could not have continued farming without them. In Montana a group of 12 ranchers when asked to evaluate their stock ponds gave estimated benefits ranging from $50 to $1,000 per year.

It is commonly thought that farm ponds are required only in the so-called arid and semiarid States. The greatest need for them is, of course, in these States; but more and more it is being recognized that areas classified as humid may have such unsatisfactory distribution of precipitation through part of the year

[1] Associate agricultural engineer, Soil Conservation Service, Washington, D. C.

that drought conditions often will prevail. Even though the total rainfall during the year may be the average or above, still there may occur two or more dry months in succession when water supplies will be depleted to the extent of water shortage. Such areas could be materially benefited by farm ponds, especially in localities where much livestock is raised.

The accompanying chart shows the average *monthly* precipitation for western Oregon and western Washington. The *annual* precipitation averages about 66 inches (about 5½ inches per month), and yet for the months of July and August the precipitation over a period of many years has not averaged much over 1 inch per month. In addition to this, the months of May, June, and September have relatively low rainfall as compared with the average monthly precipitation for the year. This condition thus allows 4 or 5 consecutive months of low rainfall during the season when evaporation losses generally are highest.



Even though in most localities the average seasonal rainfall distribution is better than that indicated in the chart, still the variation from year to year in any particular season may closely approximate such a condition. It is not uncommon in humid States, ordinarily having a monthly rainfall of 3 to 6 inches, that less than ½ inch precipitation occurs per month for as much as 2 or 3 months in succession. It is at times such as this that drought conditions prevail and sources of water supply may fail temporarily.

To control erosion, it is necessary to prevent destructive run-off of surface waters that accumulate as the result of rain, hail or melting snow. One of the best means of accomplishing this is by retention, on the drainage area, of as much run-off as possible. This is done by proper land use and approved cropping and tillage practices; and these frequently are supplemented with subsoiling, contour furrows or ridges, listing, and level terraces. Where additional run-off must be held and the terrain is suitable, considerable water can be retained by constructing dams to impound it. The reservoirs created can be utilized as farm ponds for whatever purpose is desired.

It is also possible to stabilize actively eroding gullies by converting them into usable farm ponds. This method of erosion control has been successfully used in a number of cases. Under favorable conditions it is thus possible that the farm pond serve a dual purpose by providing a water supply and at the same time controlling gully erosion. Such ponds, however, will usually silt up within a short time.

One of the most important functions of the farm pond in livestock areas is that it enables a more complete and well-balanced land-use program. Water is essential in livestock production. It not only must be available, but it must be well distributed so that livestock does not have to travel long distances to obtain it. By having several sources of water distributed over the ranch or farm unit, it is possible to rotate grazing areas and thus give depleted grassland a chance to recuperate. Only by having water available at the right places and in sufficient quantities is it possible to obtain good range or pasture management.

There is little doubt that the placing of innumerable farm ponds throughout the country will do much in moisture conservation. When it is considered that only a small pond not more than an acre in surface extent, and with an average depth of about 8 feet, will hold 2 or 3 million gallons of water, it is evident that thousands of these ponds really can conserve a great deal of water.

Types of Farm Ponds

The two main types of farm ponds are those created by:

- A. Impounding reservoirs:
  - 1. Dams.
  - 2. Levees or dikes.
- B. Excavated reservoirs:
  - 1. Dugouts, charcos, tanks, water holes, with—
    - (*a*) Natural earth or rock lining.
    - (*b*) Artificial lining.

A great many ponds are a combination of both A and B. It is common practice when obtaining material for an earth dam to excavate it from the reservoir site. Local terrain and the purpose of the pond will largely determine the type constructed. In general, it can be stated that ponds falling under A have the greater water capacity; this is because impounding reservoirs are limited to a terrain that will give considerable storage through the use of retaining structures. Excavated reservoirs ordinarily require that a cubic foot of material be excavated for every cubic foot of water to be impounded.

In an area where the land is flat and stream channels shallow or not well defined, it is difficult to find a site suitable for an impounding reservoir. An excavated reservoir is often the best solution under such conditions.

This also holds true for much of the arid and semiarid sections where evaporation losses are high. Here a deep dugout [2] with little surface exposed to evaporation is more desirable than a large pond that has much surface area exposed and considerable shallow water. To the stockman whose rangeland may extend for many miles the dugout is particularly suited. A dugout ordinarily does not involve the cost of constructing an impounding dam and, in addition, does not present the maintenance problems. This is an important feature because it is not possible to give frequent inspections to ponds that are widely distributed over an extensive area. Under such conditions a water supply that has a low initial cost and that can be depended upon with a minimum of maintenance, will be required. With reasonable care and judgment it should be possible to construct several dugouts for what it would cost to build a good impounding dam.

Experience in many places in the West has shown that large ranges often need a few big watering places in addition to numerous small ones. These big watering places help livestock through prolonged drought periods when the smaller ponds may fail, and they therefore should be strategically located if they are to serve their purpose. They enable the building up of a supply of stock water that can be held in reserve for emergency.

Another factor that may influence type of pond is local soil characteristic. Some soils have a highly impervious surface underlain by porous substrata. Under such conditions it would not be desirable to excavate a dugout because of probable seepage losses and, therefore, the impounding reservoir would be the better one to use.

Sometimes the only reservoir site available has so large a drainage area as to make impossible the economical construction of an impounding reservoir. A possible solution would be to excavate a dugout adjacent to the stream. During high-water periods most of the flood waters would be bypassed and only a normal amount diverted to the dugout.

There are many who have no need for more than a small storage reservoir and who cannot afford to construct a dam and the excavated reservoir is often the best solution to their requirements. For those who require much storage capacity, however, and who desire recreational facilities as well, the impounding reservoir is to be preferred.

[2] The terms dugout, charco, water hole, and tank mean one and the same thing.

Purpose and Location

Even though location of ponds is influenced by terrain, still the purpose for which the pond is to serve must receive consideration. For example, there is nothing gained by building a stock pond in a location so far removed from pasture or range land that the livestock must travel excessive distances for water. The number of watering places needed will depend on the relief of the area, the amount of forage available, and, of course, the climate and precipitation of the area. As has been pointed out, the use of grazing ground is limited by the availability of water and this water should be widely distributed; not just a few large supplies but many small ones also should be provided.

In gently rolling range territory, water spaced 3 to 4 miles apart is usually sufficient. In steep, rugged range country, water spaced about 1 mile apart is not too close. In readily accessible range areas of low carrying capacity, it may not be economical to provide watering places closer than 4 or 5 miles. For pastures where dairy cattle are kept the water supply will generally be well below these spacing limits because of the average pasture sizes. Dairy cows should not be made to travel as far for water as beef cattle. These figures are merely given as a guide and it is realized that they represent more or less optimum distribution of water facilities. However, they should be followed as nearly as is reasonably possible. Only in this way is it possible to avoid overgrazing around a few watering places and unused feed on other parts of the range too far removed from the water supply.

Extremely low carrying capacities may preclude any water developments whatever, but if the area is to be grazed at all, watering places should be provided. The location of stock water in such areas should be made primarily for protection of the vegetative cover as an erosion control measure.

It is not good practice to build a reservoir for domestic or stock-water supply in a location where the barnyard will drain into it. Such drainage may lead to serious contamination and at the best would produce undesirable conditions in the water supply. If the prime purpose of the pond is erosion control, then location is of course limited to the problem area. It is always desirable to locate a pond so that it will have a protected drainage area. Actively eroding and unprotected drainage areas should be avoided if possible.

An active gully head before control work was undertaken.

Other requirements, such as for irrigation purposes, have marked influence on location. Terrain or the pumping costs often are such that for economical irrigation the pond must be located near the field to be irrigated. Other locations, even though more satisfactory from a construction standpoint, would therefore be unsuitable.

Once the general location of the proposed pond has been decided upon, in best conformity with the purpose for which the pond is intended, it then becomes necessary to make a more detailed survey of the area. The larger washes, particularly those through which great volumes of water rush in times of flood, are to be avoided in the construction of ponds. Each location should be carefully examined and compared with others available before final selection is made. A detailed study will often reveal undesirable characteristics in a site that on casual investigation may have appeared satisfactory. Some of the factors which should be considered in selecting a reservoir site are here pointed out:

1. *Location with respect to purpose of the pond.*—The final site selected should be in accord with the use that is to be made of the reservoir. For example, where ponds are used for stock-water purposes, they must be spaced over the range to obtain wide distribution. Many little ponds will be required, and the number of large deep reservoirs should be restricted to the minimum. The very number will necessitate that they be of low cost. Natural spillways [3] must be used to keep down costs, and choice of site should thus go to locations where a natural spillway is available. Where a favorable site for a dugout is available it would ordinarily be selected in preference to one requiring the construction of a dam.

2. *Possible storage capacity and depth of the reservoir.*—These should be considered from the point of view of the required size of dam or amount of excavation. Generally it is desirable to insure a large amount of reservoir capacity in proportion to the size of dam required or the amount of excavation needed. A large storage capacity, however, is not always indicative of a desirable reservoir. Frequently it is found that large capacity can be obtained on wide, gentle flood plains, but that the reservoir itself will have an excessive amount of shallow water; such a reservoir might be undesirable because of evaporation losses. Final choice would thus go to a deep, relatively small reservoir that has little surface area exposed to evaporation.

The recent drought periods have evidenced that in many instances farm ponds have been provided with insufficient depth to offset evaporation losses. It is not always realized that evaporation may be most severe during a drought year. In certain localities the loss in some years may be as much as 7 or 8 feet. This is sufficient to nullify completely the capacity of an average pond if no replenishments ensue. It is felt that in general the farm pond should have a minimum depth of 8 feet in subhumid areas, 10 feet in semiarid, and 12 feet in arid sections. A 6-foot minimum depth should be provided in humid areas.

3. *Drainage area contributing to reservoir.*—Size, shape, slope, and cover should be investigated. The drainage area is an important factor in the selection

[3] Natural spillways are assumed to be drainageways requiring no further excavation, and in which the native sod is utilized.

The same site a year later. An earth dam has impounded the water. The spillway crest has been made sufficiently high to prevent destructive action at the gully head.

of the site. It must be sufficiently large to maintain the reservoir water supply even during years of drought, and yet not so large as to present a constant flood menace to the pond. The area must not be actively eroding, else silt will nullify pond capacity in a short time.

Experience seems to indicate that the minimum drainage area required, in acres per acre-foot [4] of pond capacity, will be for average conditions from 3 to 6 for humid areas, 5 to 30 for subhumid, 25 to 60 for semiarid, and 50+ for arid. The seemingly wide range of figures merely indicates that local conditions influence the size of drainage area to be selected and that no set rule can be given that will apply equally to any and all conditions.

4. *Type of soil.*—It is well to check carefully the soil on both the drainage area and the reservoir site. A porous soil on a relatively flat and well-vegetated drainage area may mean insufficient run-off to supply the pond. Certain soils are also unsuitable for reservoir sites because of seepage losses.

5. *If dam is to be constructed, foundation, fill material, and spillway possibilities should be considered.*—In many instances no natural spillway is available and if a mechanical spillway is too expensive to construct the site must be abandoned. In some localities it is impossible to find suitable fill materials for earth embankments or proper aggregate for masonry structures; this may become a deciding factor in choosing a site. For small earth dams, foundation conditions may be generally satisfactory, but may involve certain difficulties such as porous strata of shale, gravel, sand, or even peat.

[4] An acre-foot of water is the equivalent of water spread uniformly over 1 acre of surface to a depth of 12 inches.

An item often overlooked in the design of a farm pond is protection of the reservoir against silting. Numerous examples might be cited, in all sections of the United States, of reservoirs partly or completely filled with silt. In certain instances complete silting of the reservoir has occurred within a period of only 2 or 3 years. Many reservoirs have only one-half to one-fourth of their original capacity because of silting. Frequently the owner of the pond is entirely unaware of the extent or seriousness of silting until most of the reservoir capacity has been destroyed.

The best protection against silting is attained by selecting a pond site that receives run-off from a drainage area on which erosion is under control. Cultivated, overgrazed and burnt-over lands all contribute considerable silt to surface run-off and should not be utilized as the primary water source for farm ponds unless nothing else is available. A drainage area consisting of woodland, meadow, or pasture is much preferred. Good land use thus enters into the design of farm ponds in that it is essential in protection against silting.

Where only actively eroding drainage areas are available it is suggested that erosion-control practices be installed and placed in operation for a period of at least a year or two before the pond is constructed. A practice frequently used for silt protection is that of placing a border strip of close-growing vegetation along the upper part of the pond. This border strip is so placed that all run-off water from the contributing drainage area must filter through it before reaching the pond. These protective strips should have a width of at least 200 feet and, preferably, more. They should be established before the pond is constructed. This type of silt protection is generally the most economical

178818—39——2

in areas where vegetation can be established. It is desirable also to establish a growth of woody plants in the strip, as they are more effective than grass in contributing to desilting during heavy run-off.

Another practice that is sometimes used, especially where large drainage areas are involved, is that of designing the reservoir so that the major part of flood run-off is bypassed and only a small part diverted into the pond. In this way most of the silt-laden waters will not have opportunity to deposit their load in the reservoir. When only a small amount of run-off occurs it will all be diverted into the reservoir.

Wildlife

With little additional effort a farm pond can be converted into a wildlife habitat that will be a source of pleasure and sometimes a source of income to the owner. This holds true primarily for the impounding reservoir; but on rangeland where large numbers of widely scattered dugouts are used it is not always economical to provide the full protection desirable for wildlife.

Many States, including most of those in the West, have laws regulating the construction of dams beyond a certain height or the impounding of water for storage purposes. Even in the States where no permission is required to store water, the natural flow of surface streams must not be changed to the injury of owners of riparian tracts farther downstream. Should such injury result, the builder may become involved in costly damage suits.

In the malaria sections of the United States the Public Health Services generally have certain restrictions on water storage in open reservoirs. This is necessary in order to control the mosquito that acts as carrier of the malaria germ.

Since no two States have precisely the same laws and regulations affecting construction of dams, water storage and water rights, it is not feasible to summarize them here. Furthermore, such laws and regulations are continually being changed or altered. It is suggested that, wherever construction of a reservoir is contemplated, inquiry be made through local authorities as to possible restrictions.

SOME ECONOMIC AND SOCIAL PROBLEMS OF SOIL CONSERVATION

(Continued from p. 76)

In the case of structures such as terraces, permanent dams and diversion ditches, most of the farmers stated that they would not erect them without assistance.

This indicates that certain parts of the program may be generally accepted while some parts, especially those involving large capital outlays, may not be accepted without some form of subsidy.

The effect of the program has been to increase the quantity of roughage feed and, in most instances, reduce the quantities of grains. The increase in roughage will be used to reduce overgrazing during the dry summer period; some will be plowed under as green manure, and some will be used up by feeding a larger number of roughage-consuming animals. There was no indication that a smaller number of hogs would be raised, and the study indicates that the number of hogs raised on any farm was not correlated with the percentage of the land in intertilled crops but was correlated with the amount of feed bought and sold.

No final conclusion can yet be reached regarding the effect of the program upon the net farm income. Bulletin 381 outlines the factors to be considered by each farmer when he must make a decision whether to adopt or not to adopt a conservation program. In general, the study indicates that in southern Iowa conservation is economic, that the soil conservation program is effective in controlling erosion and that it has largely been accepted by the participating farmers as a permanent system.

CUTTING AND USE OF BRUSH IN EROSION CONTROL

By J. W. DEPPA [1]

BRUSH pruned from piñon and juniper stands has been used extensively to control erosion. Every conceivable type of brush structure has been built, ranging from thin mats to huge piles of brush placed as dams in gullies or in water spreading systems. That part of the following discussion which applies to the silvicultural aspects of brush cutting from live trees refers only to the piñon-juniper forests of southwestern United States.

In obtaining the brush, various cutting methods have been followed. A cutting system often used consists of lopping off all basal branches with axes, although experience has shown that saws in the hands of trained men can result in as good production with less personal danger involved. The use of saws also leads to better cutting practices.

Cutting all the basal branches from a tree exposes the accumulated litter and duff to excessive drying and to removal by wind and water. Thus serious damage may result on steeper sloping areas and places where the grass cover does not adequately protect the site from erosion. On trees primarily valuable for watershed protection, great care should be exercised to avoid reducing their effectiveness. Where the trees are on steep or eroded hillsides, the removal of branches which provide soil protection could scarcely be justified, no matter how scientifically the brush might be used in stopping erosion at some other place.

Conservation work, including brush cutting, ought to lean toward conservation practices. Brush cutting might well be done by what is sometimes called the "concealed cutting system." This method yields considerable brush without jeopardizing the production of posts, in the case of juniper, and may safely be used on potentially erodible sites simply by reducing the intensity of the pruning.

From one-tenth to one-fifth of the tree crowns may be removed without significant reduction of ground cover effectiveness and without appreciable damage to the vitality of the trees. Emphasis should be placed on the preservation of those branches nearest the ground, as they are especially valuable in preventing loss of litter and duff from beneath the trees. This litter and duff accumulating under the trees often preserves the only organic and permeable soil remaining on many sloping areas.

[1] Soil conservationist, Soil Conservation Service, Albuquerque, N. Mex.

A concealed cutting removed a compact pile of brush 4 feet high from the tree behind. A 12-foot pole saw was used. A somewhat shorter handle and a stiff and fairly coarse saw is also practicable. Note that the basal branches have not been disturbed. Under some site conditions, even more brush could be taken.

Brush has several characteristics which govern its proper use. It is somewhat temporary in nature, light in weight, and makes a permeable construction material. Its relationship to vegetative growth which may be covered in construction, or which may be planted or appear later as volunteer growth, is especially important, since the brush may assist the vegetation or damage it according to the density of placement.

Using brush in the construction of large and solid structures should be the exception, rather than the rule, because brush, no matter how carefully placed, only retards flowing water; it seldom packs tightly enough to prevent all undercutting. If a thick brush gully plug is placed in erodible soil, it will almost invariably be cut under or around, leaving the brush work high and dry. Any slight impounding effect which the plug then may have will only tend to build up a head of water that will cut previously made holes deeper and larger. In a soil that resists erosion, such as

decomposed granite or other rock, a fairly large porous plug may seal tightly and cause complete filling of the dam, but the net benefit of such work is debatable The governing fact is that brush disintegrates within a few years at most, after which time the silt bed formed may be entirely or partially destroyed.

A 2-inch deposition of silt will show that erosion has been stopped just as conclusively as a 2-foot layer. Anything above a minimum fill is in the nature of reconstruction, which, although often justifiable, in most cases might be left to the more gradual but infinitely more permanent development of a vegetative retardant that can be established just as well or better on fills inches deep as on unstable deposits several feet deep behind shaky brush dams.

Instead of stopping erosion by sheer mass of construction, it is suggested that in most instances the job of control and rebuilding be modeled after the age-old processes of nature—filtering muddy water through vegetative growth, dropping that portion of the silt content which can remain on a stable plane permitting natural vegetation. The process is repeated indefinitely in nature, and although losses as well as gains occur, the natural healing method can be successfully imitated.

Because it is impossible permanently to maintain brush structures, they must serve their purpose before disintegration occurs. We believe that, ordinarily, plans should be drawn so that the brush structures will convert or metamorphose into vegetative structures capable of taking over and continuing the healing process. Many types of brush structures not only cannot meet this requirement, but all too often kill vegetation already established. The solution is to use brush of a type and in a manner that will meet the requirements of plant growth rather than of engineering design.

In a region such as the Southwest, site conditions often are unfavorable to vegetative growth, and barren spots are covered very slowly, if at all. This is largely due to the high soil temperatures, the beating effect of heavy rains with resultant erosion and the cracking and heaving of the soil surfaces. In addition, such exposed sites offer no protection against the activities of rodents and birds always alert to pick up seeds.

Brush scattered over such places will give protection to struggling vegetation in much the same way as lath shades in a plant nursery or burlap cover on new lawns. It will reduce the intensity of the sun's rays and retard evaporation by shading and by reducing wind action. As needles or leaves drop from the brush, which should be green when placed, a diffused mulch will form on the bare soil. Equally valuable are the resultant reduction of soil movement or erosion, the retention of water, and the deposition of layers of silt during storms. These layers should not be so deep as to overwhelm seeds or seedlings or established vegetation.

Too much brush laid over a planted area, or one having some native vegetative growth, would act in the same manner as complete shade over a nursery, or an impervious covering over a new seedbed. Not only would it prevent the development and growth of new plants, but it would kill or devitalize any plants already present.

In an experiment which was set up to determine the influence of brush on the growth of natural vegetation on barren areas, it was found that in 1 year's time a light covering of brush resulted in much heavier vegetation than that on check plots with no brush covering. On one plot, 6-weeks-old grama developed to two and three times the height of the same species on an unbrushed plot. Growing through the brush the grama produced large seed heads, whereas without the advantage of the brush the seed heads were not equal in size or profusion.

Recent brush work done in the Rio Grande watershed has shown a number of contrasts between light and heavy brush work. In one particular area thousands of square yards of thin brush mats were laid down, and they have shown strikingly that only a very small amount of brush is necessary to cause an appreciable dropping of silt and other debris, thus greatly improving the habitat for plant growth, especially for the grasses.

It often has been argued that light brush work cannot withstand heavy flows of water, and that heavier plugs weighted with rock or tied with wire should be used instead. However, gullies which are too large to be controlled with simple brush mats with an occasional small anchoring, are usually too large to be worked with brush. There seems to be little point in accumulating a mass of silt unless definite provision is made to secure vegetative growth within the life of the brush, which growth will prevent the silt from continuing its progress dowmstream.

As to the method of laying brush, there are those who advocate placing the tips of the brush upstream, others who argue that the tips should be placed downstream, and yet others who say that it makes no difference. The method of laying is not vital in all instances, although if a satisfactory mat is to be placed

(Continued on p. 86)

Erosion-Control Lessons From Old-World Experience

I. STRIP CROPPING BY INHERITANCE IN FRANCE

By W. C. LOWDERMILK

ANY TRAVELER in rural districts in France is likely to be impressed by the general evidence of cropping in narrow strips. But the strips run up and down slopes as well as across slopes and the practice is not a feature of purposeful or planned erosion control, but is the outcome of repeated divisions of land under the laws of inheritance. These old laws constitute a serious burden on efficient agriculture in France.

During feudal times large tracts of land were held by lords, dukes, and landed gentry. After the revolution their properties were divided equally between heirs of successive generations who in turn divided them into smaller parcels to their multiplying offspring. Only limited numbers of the old, large ownerships are left which have not thus suffered repeated subdivision.

When a large land holding is thus divided and subdivided, in a few generations, into literally thousands of small parcels, with each owner or occupier attempting to farm his land in several narrow strips, the problem of efficient agriculture is serious. Sometimes the strips are no more than 10 feet wide and are hundreds of feet long.

The first consideration in a division of land for separate heirs is access to the serving road to avoid trespass and to assure rights of use. Division must be along the serving road, and in only one dimension, and thus in time a tract of land is parceled into bands of narrow strips or ribbons. The land of a proprietor generally consists of many narrow strips separated by other ownerships. Liberty in the use of his land is limited by size, practices on adjoining strips under other ownerships, and by scattered location of separate strips. Strips as narrow as 10 feet and in extreme cases no wider than wheel tracks may run back from the road for hundreds of feet, approximately at right angles to the road.

If the serving road runs along the valley, strips bordering the road run up and down the slope; if the road is up the slope, strips run across the slope. In the latter case many years of plowing strip fields as separate units across the slope has produced a "benching" of the land, and this has proved a most effective means of erosion control on the steeper cultivated slopes. A bordering hedge is most effective in benching the land. The origin of benching is under discussion; some claim it was done by hand labor, others contend that it has been produced gradually under plowing.

Rural land-ownership maps show almost unbelievable subdivision. A map of the Commune de Quevilloncourt shows how an area of 214 acres is subdivided into 815 separate parcels of land, owned and operated by 105 different farmers. In the Commune of Davanescourt an area of 380 cultivated acres is divided into 1,349 strip parcels. In the Commune of Malmy an area of 214 hectares (505 acres), under 47 owners, exists in 750 parcels. In the territory of Avancon an area of 1,609 hectares (4,022 acres) lies in 3,608 separate strip parcels. In the Department of Ardennes, a survey by the Direction of Waters and Rural Engineering disclosed that an area of 48,688 hectares (120,720 acres) in 8,619 ownerships comprises 179,818 separate parcels of land. Excessive subdivisions of the land by laws of inheritance are not exceptional but are general, and for this reason place a heavy burden upon French agriculture. A few larger ownerships remain intact or in larger tracts, and there is a tendency for owners to buy up adjoining parcels to block out sizable farm units, but this is a slow process.

In 1919, so serious had become the problem of using land thus minutely divided that government action was necessary. The act of May 4 of that year was passed to place the services of the Direction of Waters and Rural Engineering at the disposal of farmers who would form syndicates for the consolidation of their holdings, for adjustment of boundaries, and for the relocation and building of additional serving roads. This service has become one of the major activities of the Direction of Waters and Rural Engineering. The law provides a service to farmers who wish to take such action. No coercion is attempted, for French farmers are a highly individualistic group, tied to the land and customs of their fathers. The Director of the Agricultural Services for the Province, an official similar to our State Director of Extension, publicizes the provisions of the law and informs and assists landowners in forming syndicates of farmers for consolidation of their holdings. While considerable action has been taken,

it by no means solves the problem of parceled land. Many agricultural authorities consider the act insufficient to the needs of the situation; yet the accomplishments to date are important.

Out of a total of more than 121,720 acres treated under the act, 179,819 separate parcels originally existed under 8,619 owners. Consolidation of parcels and adjustment of boundaries reduced this number to 38,136 holdings. To serve these adjusted tracts, the Direction of Rural Engineering built more than 500 miles of new roads. When a block of land containing many parcels and owners is similar in character, the advantages of larger tracts are sufficient to induce farmers to get together for the purpose of land-boundary adjustment and consolidation. In the Commune de Quilloncourt area of 380 acres of 105 owners, the 815 parcels were consolidated into 216 parcels. In the Commune of Davanescourt, of 380 acres, the 1,349 parcels were consolidated and reduced to 64 separate holdings.

An interesting example of consolidation is that being carried out by a Mr. Schlumberger of Alsace in the upper Rhine Valley. His estate of 275 acres, in vines, is a consolidation of 3,030 separate parcels. These vineyard properties are on slopes varying from 20 to 45 percent. Mr. Schlumberger is proceeding with a program to change the direction of vine rows, from up-and-down the slopes of former narrow strips to contour rows. He is constructing retaining walls on the contour with concrete outlet channels and storm drains. He gradually fills in the valleys so that the former drainage channels of the slopes are eliminated. Thus he has entirely transformed the area into contour cultivation and terracing for soil and water conservation and erosion and run-off control.

The people of these vineyard sections are alive to the damages of erosion and storm run-off, but there is little for a man to do who possesses a parcel only 10 to 15 feet wide, extending several hundred feet up a steep slope, unless he builds rock terrace walls or joins a syndicate for the readjustment of holdings. So individualistic are the land owners of this section, however, that the latter move is unlikely for the present. Thus these small strips running up and down the slopes have resulted in serious erosion in the vineyards of Alsace because of lack of coordinated effort and efficiency.

Up until the World War, cultivation was almost entirely done with the hoe. The irregular surface and piles of cut weeds left by hoeing were a deterrent to erosion on the up-and-down strips. Since the World War, horse-drawn cultivators have been used and they greatly accelerate erosion because of the formation of cultivation furrows up and down the slopes. At Kaysersberg there is a channel, 18 by 18 inches, which was sufficient to carry away the run-off under the condition of hoe cultivation. But now, after heavy rains, the current overflows the former channel to a width of 10 feet and to a depth of more than a foot, and then sweeps down the road, carrying destruction whenever it flows across fields and vineyards.

The solution, of course, is the consolidation of land ownerships by exchanges and purchases, and the building of additional service roads. Strip cropping has been forced upon France under the laws of inheritance, and one gets some conception of advantages that would result from a general use of such practices were they designed especially for the purposes of erosion control and soil conservation.

CUTTING AND USE OF BRUSH

(Continued from p. 84)

the brush should be handled more or less as individual pieces rather than as piles or bunches.

A given amount of brush will offer more resistance to stream flow if the tips are placed so as to point upstream. It is the baffling effect of the brush which slows up the water and causes deposition of the debris; therefore, the greatest retardation per unit of brush will be secured by the upstream tip placement. A brush mat can be made rapidly and well by thrusting the butts of the pieces into the tips of brush previously laid, working in an upstream direction.

Ordinarily, in placing brush in a gully, if the gully is not too large for this type of work there should be little danger that the brush would be rolled into a jam or moved appreciably by the flow of water—this, since the immediate action of a flow of muddy water encountering a brush mat is to drop the heaviest part of the silt load, thus anchoring the brush. This effect practically is positive if the mat is so thin that it does not offer too much resistance to the flow of water. If brush is to be used where there might be danger of movement during storm periods, it would be advisable to weight the brush or use wire ties of the butterfly type for anchorage. In instances when anchoring is not practicable, and larger flows are feared, the butts of the branches might well be placed upstream to lessen the resistance to the flow.

From the woodland point of view the manner of obtaining brush from the tree is more important than the method of its placement, since the living and growing branches if left on a tree often may have

(Continued on p. 92)

A solid block of farms in the Wilson Hollow watershed under a single scheme of conservation practices. A clear depiction of the advantages of watershed planning without regard for property lines. The terraces continue from one farm to another without a break. Cooperative channels are used. Wilson Hollow is a tributary of North Elm Creek.

FARMER COOPERATION IN THE BLACKLANDS OF TEXAS

By WILLIAM H. WITT [1]

DOWN in the Blacklands of central Texas is one of the Nation's largest blocks of conservation-treated land—165 farms covering 30,000 acres. Farmers here are ready to set up one of the State's first soil conservation districts. Petitions from farmers in Bell, Falls, McLennan, and Milam Counties have been submitted to the State Soil Conservation Board—petitions requesting the formation of the Central Texas District, covering 750,000 acres.

The story behind today's outlook reveals an important fact: farmer cooperation made such an achievement possible. The rapidity with which central Texas farmers set machinery into motion for the establishment of a soil conservation district under the new State law, signed by the Governor late in April, indicates that these men want to see the 30,000-acre block lengthened and broadened to 750,000 acres.

When the Soil Erosion Service project was established at Temple in 1933, to assist farmers in Bell, Falls, McLennan, and Milam Counties in demonstrating the practical control of erosion, the work area was designated as the 206,000-acre watershed of Elm Creek. This watershed includes Little Elm, Big Elm, South Elm, and North Elm Creeks. The first work was started in Big Elm watershed in December 1933.

Farmers in the entire Elm Creek drainage basin knew before, or shortly after the conservation program was started on the upper reaches of Big Elm, that erosion control was to be undertaken on a watershed basis—beginning at the crest of the divide and working down, farm by farm, until the banks of the stream were reached. They were interested and they made it their business to find out what was going on.

Among the men who closely followed the activities in Big Elm were certain key farmers in North Elm. They had long recognized the presence of a serious erosion problem. Some of them had farmed the Black Waxy prairies for many years. They had seen the coming of the railroads in 1881 and the rise of "King Cotton," in whose wake came devastating erosion. There were men among them who remembered the stories their fathers had told of the original Blackland Prairie and its covering of long and short prairie grasses, principally the bluestems. This area, frequently referred to as "the land as fertile as the Nile Valley," originally was ranching country and it was

[1] Assistant information specialist, Soil Conservation Service, Fort Worth, Tex.

not until after the War between the States that cotton was planted on the uplands—cotton which soon became the principal crop. With the advent of the railroads came new outlets for marketing cotton, and more settlers to plow up the prairies and plant "white gold," in up-and-down-hill rows.

These men of the Blacklands had seen erosion skim off precious layers of rich black topsoil and watched with growing alarm the appearance of light colored patches on their fields—evidence that the productive soil layer was going down the creek at a rapid rate. Crop yields had declined, year by year, and overflows were becoming increasingly damaging to croplands as streams became clogged with silt. They had tried to control this loss, but they needed help.

Early in 1934 these North Elm leaders took their problems to Service technicians. The first delegation explained that North Elm farmers were interested in the same kind of assistance that was being given to Big Elm farmers. They said they believed that most of the farmers in their watershed wanted conservation systems on their farms. Service technicians assured them that assistance could be extended to North Elm if at least 90 percent of the farmers in the watershed would cooperate so that an effective watershed demonstration could be put into effect. Technicians agreed to attend community meetings called by the farmers and explain the soil-conservation program.

The meetings were held and leaders in each community selected a committee to assist in interviewing farmers. Committeemen immediately went into action. Each carried a petition which requested the Soil Erosion Service to assist North Elm farmers in the establishment of conservation practices. The signer agreed to cooperate by putting conservation practices on his land. Key farmers made flying trips over the watershed by horse, wagon, or automobile, or afoot, visiting neighbors and urging that they join the movement for watershed control.

By the middle of June 1934—only 2 weeks after leaders started circulating their petitions—242 farmers owning or operating 37,000 acres of land in North Elm had signed up. The 90-percent stipulation had been met in 2 weeks. There are 267 farms and 41,000 acres in North Elm.

The petitions were handed to Service representatives in Temple and plans were made to give assistance to North Elm farmers as rapidly as possible. Community meetings were held at which farmers organized soil conservation clubs. Members assisted the Service technicians by explaining the details of the program to other farmers and in obtaining signed agreements setting forth both the Government's and the farmer's contribution to the erosion control program for each farm. Technicians attended community educational meetings and explained the program. These clubs which served such a useful purpose in the early stages of the work later merged to form the voluntary soil conservation association.

Erosion control planning for the area was based on the watershed, without regard to farm or county boundary lines, since the area lies partly within the counties of Bell, Falls, and Milam. The planning of several farms as a single unit speeded up the work and simplified the preliminary procedure—thereby reducing planning costs. The first agreements entered into by the Service and farmers covered 34,000 acres—29,178 acres of which were in one solid block of 165 farms, representing a land area of nearly 45 square miles. Later additions of land brought the solid block's size up to 30,000 acres.

Another solid block in the North Elm watershed, but outside the 30,000-acre area, is composed of 16 farms, covering 2,578 acres. Every farm in this smaller block also is protected against erosion by soil and water conserving practices.

Actual control work on 150 farms was started early in July 1934. Service technicians assisted farmers by making individual farm plans, laying off lines for contour rows, strip crops and terraces, designing outlet channels and by furnishing small fresnos and graders for excavation and construction work. The farmers constructed the terraces and outlet channels. Two-thirds of the cost was borne by the farmer and a third by the Government. In order that all needed supervision could be furnished individual farmers, key men—usually those who had helped to organize their respective communities for erosion control—were selected to work with their neighbors and aid in the proper installation of erosion-control practices and structures.

The original work in this solid block was similar to that being done in States having operating soil conservation districts. The incentive for the initiation of an erosion-control program came from farmers, and most of the actual installation work was done by farmers. Thus, the complete conservation systems in operation on North Elm farms stand today as monuments to farmer cooperation.

Twelve cooperative terrace systems, serving 35 farms, in which terraces cross 2 or more farms without a break, are in operation in the solid block. Each of 6 terrace systems serves 2 farms; 4 serve 3 farms each; 1 serves 4 farms, and 1 system serves 6 farms.

One hundred farms are involved in 42 cooperative terrace outlet channel systems that drain water from 2 or more farms. Each of 32 of these channels serves 2 farms; 8 serve 3 farms each; 1 handles the water from 5 farms and another drains water from 6 farms.

By working cooperatively and permitting terraces from one farm to extend across the farm boundary on to the adjoining farm, or farms, the farmers have been able to omit entirely some terrace outlet channels that would have been constructed and maintained if each farm had been planned as a separate unit. This naturally reduced the amount of work each farmer had to do in excavating and sodding for establishment of terrace outlets and outlet channels.

Where cooperative drainage systems were installed, all farmers involved entered into formal drainage agreements to ensure protection of the rights of each and to perpetuate the system.

Utilization of all land on the farms for some profitable purpose was emphasized in connection with the establishment of conservation systems on North Elm farms. This principle was put into practice by the fencing of natural drains used as outlets for terrace water or of constructed outlet channels, so that they could be used as pasture. In some instances it was discovered that fields were so situated that a planned outlet channel could not be utilized by the farmer because of its inaccessibility to the regular pasture. Here a cooperative plan was worked out with an adjoining farmer making it possible to extend terraces across the farm boundary to a channel so located that it could be properly utilized as pasture. Grazing rights were defined, and stipulations regarding the use of cooperative channels or other drainageways were included as a part of drainage agreements so that proper maintenance of channels could be guaranteed over a period of years.

Where terraces meet on farm boundaries, a joint outlet channel is used, each owner giving half of the land needed for the channel. This results in the most practical utilization of the land, the most economical outlet control and maintenance. One farmer may be permitted to use the channel for grazing in return for maintaining it, or two or more farmers may pool their time and labor to ensure proper maintenance.

An excellent example of the spirit of cooperation which predominates in North Elm is to be found on the farms of Anne and Ella Frerichs, F. J. Neinast, and Mrs. John Kahler. These three farms are located one above the other on a long slope, the Frerichs farm being at the top of the divide and the Kahler farm on the lower end of the slope next to Wilson Hollow into which drainage water from all three farms flows. The three farms comprise a small interior watershed, and plans for the installation of conservation systems treated the three as a single unit without regard to property lines. A draw, which cut through the three farms from the divide to the creek, was utilized for the construction of a terrace outlet channel into which terrace water from all three farms would empty. All terraces on the three farms cross property boundary lines without a break and stretch in an unbroken line to the channel.

The drainage agreement which was entered into by the owners of these farms states that the owners agree to permit terrace run-off water from the neighboring farm to flow across farm boundaries, enter terrace channels on either farm, and flow through the cooperative outlet channel to the natural drain. By this agreement Anne and Ella Frerichs were permitted to estabish conservation practices on their land. Without the cooperation of the two owners on the lower end of the slope the operators of the Frerichs farm would have been confronted with a serious problem in locating a proper outlet for terrace drainage water. Similarly, the Neinast and Kahler farms could not have been treated until conservation practices had been installed on the Frerichs farm. Uncontrolled run-off from an untreated Frerichs farm would have made conservation practices on the Neinast and Kahler farms of little value. In this instance all three owners have joint responsibilities in maintaining the outlet channel. Each owner agrees to maintain that part of the channel located on his farm.

Channel maintenance and the use of the channel for grazing is included in the drainage agreement entered into between two other farmers in the solid block who have a cooperative channel—A. A. Winkleman and Frank Monroe. The two farms are situated one above the other on a slope, the Winkleman farm being at the top of the hill.

A cooperative terrace outlet channel has been constructed on the boundary between the farms. Under the terms of the drainage agreement Mr. Monroe is permitted to utilize the channel since it connects with his pasture. Inasmuch as the channel is located at a distance from the Winkleman pasture, Mr. Winkleman has been glad to permit Mr. Monroe to use the strip as pasture. In return, Mr. Monroe maintains the channel.

Mr. Winkleman has this to say about the cooperative arrangement: "I think watershed planning saves work and maintenance because the run-off water goes where it is naturally supposed to go. By cooperation the

work and expense is reduced to a minimum. I think a cooperative channel that can be utilized by one of the cooperating farmers is a good idea. Since the channel which Mr. Monroe and I use is located on the back of my farm, away from my pasture, I can't use it. And since Mr. Monroe can use it as extra pasture, I am glad to have him do so since it makes it unnecessary for me to do the work which would be required to keep the channel from silting."

And other farmers of North Elm are enthusiastic about cooperation and watershed planning. Bartle Crennan, for instance, says: "William Hoff, who has a farm above mine on the slope, has helped me solve a major control problem. I had been having trouble keeping my terraces maintained due to the fact that I received run-off from the Hoff farm. When Mr. Hoff terraced his fields, my terrace maintenance problem was solved."

Mr. Hoff's side of the story is also interesting: "When Mr. Crennan permitted me to empty terrace water from my fields on to his pasture it saved me the expense of constructing an outlet channel on my land. It not only saved the cost and work of constructing the channel but it saved me the land the channel would have occupied and the work I would have had to perform to maintain the channel. I think cooperation between farmers in erosion control work is necessary if the best job is to be done."

Some farmers whose lands are located on lower ends of slopes have been responsible for convincing their neighbors on the upper slopes that they too should adopt conservation practices. In most instances, treatment of lower lying farms was delayed until all farmers on a slope had decided to work together in establishing an effective erosion control program. The farmers "on the hill" quickly recognized that it would be impractical for their neighbors on the lower reaches of the watershed to apply erosion control practices if those above failed to control soil and water.

Visitors who come to Temple from all parts of the world to see this agricultural development are impressed with the modern farming picture they find. Standing on some of the highest points in the area one may look out over conservation-treated farms extending as far as the eye can reach. Terraces stretch in unbroken lines across the slopes. Rows of cotton follow the contour across the slopes, and interspersed between these row crops are erosion-control strips—small grain, sorghum, Hubam clover, and bluestem grasses.

Cooperating with nature and with each other, Elm Creek farmers are saving for posterity the nation's most priceless asset—the soil.

EDITOR'S NOTE.—The total area under agreement in the Elm Creek project demonstration covers 82,000 acres in 613 farms, including the 30,000-acre block in North Elm. This area includes conservation-treated land in North Elm and Big Elm watersheds.

HUBAM CLOVER IN THE TEXAS BLACKLANDS

By C. H. BATES [1]

AN APPRECIABLE reduction in the productivity of soils as a result of depletion of organic matter and other plant food elements has been observed throughout the Black Waxy Prairie of Texas. The loss of these materials has been the consequence principally of progressive, unhampered erosion and continued removal of crops, chiefly cotton. Agricultural leaders point to the decline in average yields of cotton over the area as an index of the productivity trend for the Blackland farms.[2]

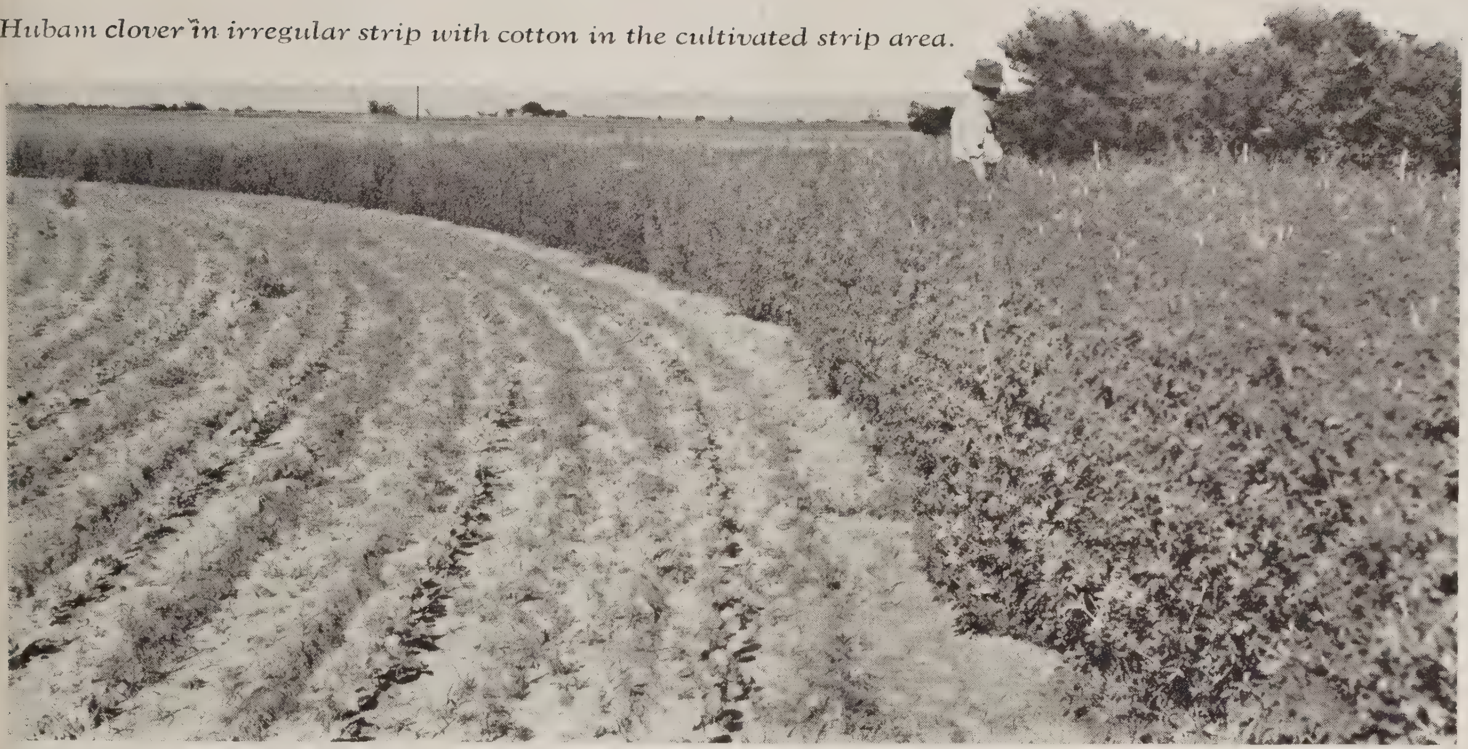
Figures from a farm business survey made in 1934 by the Soil Conservation Service, on 291 farms within and adjacent to the Elm Creek watershed area, show that cotton occupied 64 percent of the total cropland, corn 20.4 percent, and other clean-tilled crops such as forage sorghums and Sudan 4.5 percent. These figures indicate that slightly less than 90 percent of the crop area on farms of this section was in clean-tilled crops. Such cropping practice makes difficult the adoption of an effective system of rotation. For this reason the supply of organic matter has been rapidly depleted, with very slight chance for renewal during normal cropping operations. This loss due to continuous cropping, plus the damage from run-off, continues to "eat away" the remaining portion of the originally deep and fertile layer of topsoil.

The Soil Conservation Service demonstration projects (located at Temple, Garland, and Lockhart) within the Blackland region have encouraged the adoption of crop rotations and certain other soil-building practices. Because of attacks upon most legumes by the cotton root rot fungus, these crops have not been very generally used as soil-building agents in the Blacklands. Some farmers near Marlin,

[1] Associate agricultural economist, Soil Conservation Service, College Station, Tex.

[2] The reduction in total acreage planted to cotton during the past few years has doubtless affected the recent trend as compared to previous periods. C. H. Bates: unpublished manuscript, 1939.

Hubam clover in irregular strip with cotton in the cultivated strip area.



in Falls County, Tex., for a number of years have planted Hubam clover (*Melilotus alba annua*), an annual legume, for soil-building and other purposes. The crop is usually drilled in October and early November or in the late winter—February 20 to March 15—and makes its heaviest growth during late April and May. Normally, this is a season of heavy rainfall and soil conservationists have given considerable attention to cover crops such as Hubam, to afford some measure of protection from excessive run-off. Because of its luxuriant growth, usually 3 to 5 feet in height, and its very deep root system, Hubam clover doubtless has promise as an erosion-resisting and soil-building crop for use in the soil conservation program for the Blackland region of Texas.

In the fall of 1934 and the spring of 1935, the demonstration project at Temple made limited distribution of Hubam seed to a number of cooperating farmers, but unfavorable planting seasons caused poor stands. The first real test of the crop on the demonstration project came during the winter and spring of 1935–36, when the fall plantings were made with ample moisture in the soil. Much interest developed among farmers of the area because of the remarkable showing the clover made, both as a soil-building agent and as an erosion control crop. It was clearly demonstrated in this test that this legume would mature by early July, before danger of serious attack by cotton root rot.

The widest use of Hubam, in the crop disposal system, has been for green manure. Where cotton and corn followed this crop, yields invariably were increased. In 1937, yield measurements were made on several fields of cotton growing on Houston black clay which had less than 25 percent of the topsoil removed by erosion. The average yield from adjacent check plots of cotton following cotton was 257 pounds of lint per acre, while from cotton following Hubam (turned under in the summer of 1936), the yield was 293 pounds, an increase of 14 percent. Similar tests on corn showed an increased production of 16 percent on the Hubam treated fields. For the years 1937 and 1938, the average increase in cotton yield, following the clover, was 18.6 percent.

Only 1 year's results have been obtained for corn. On one farm located on the Garland project, it is reported that in 1938 wheat planted after corn produced 8.1 bushels per acre, while that planted following Hubam produced 18.1 bushels, an increase of 123 percent. Obviously the results from 1 year's observations are not sufficient for definite conclusions as to what may normally be expected.

No tests have been made to determine the residual or "carry over" effect of Hubam upon yields from the fields in the second and subsequent years. However, farmers report that cotton on treated areas has shown noticeably increased vitality the second season following the clover. An increased production for several years would be necessary to make up for the sacrifice in cotton or corn production for the year the clover was growing. However, periodic green-manure crops would reduce further depletion of organic matter and

tend to maintain crop yields at present levels. Occasionally, moisture conditions would be such that a crop of Sudan or late sorghum could be grown the same season, following Hubam. Should the recent acreage reduction of cotton and other erosion inducing crops be continued, the use of green-manure crops should prove more feasible.

While the greatest economic value of Hubam clover in the Blackland farming program probably lies in its use for green manure and as an erosion control cover, the crop affords some additional economic possibilities.

A combination use of Hubam with fall-sown oats, especially in the strip cropping of terraced farms, has been adopted by some Soil Conservation Service cooperators near Temple, Tex. The clover is seeded on top of the grain in late February, and the oats are cut for hay about May 10 to 15. With ample moisture in the soil the Hubam emerges and produces a good growth as a green-manure or seed crop. Under this practice the protection of the contour strips is afforded the soil from early winter after oats begins growth, until the Hubam is taken off in midsummer. One disadvantage is encountered with the oat hay utilization in that it is not practical to bale small amounts from the strips, and usually it is wasted badly by livestock if fed loose.

Some farmers in the project areas already mentioned have been able to market profitably the seed produced on small acreages of Hubam. In 1934 the seed was selling for about 16 to 18 cents per pound in quantities. Small amounts sold as high as 25 to 30 cents. With an average production of some 450 to 500 pounds of Hubam seed per acre, and when this yield can be marketed at 10 cents a pound, growers have found the gross return from the crop very attractive. However, in 1938, producers in the vicinity of Temple were satisfied to dispose of their surplus Hubam seed at 8 cents a pound. Probably as local supplies of the seed accumulate and as new growers learn to harvest enough for their needs, the market for Hubam seed will be very limited, except during seasons following crop failure due to drought or other causes.

Hubam may be utilized as a forage crop, although the hay produced is usually of a rather coarse stemmy quality. Livestock must learn to relish it, and some farmers have become discouraged in their attempts to get workstock or cattle to eat the hay. Some have found that their livestock readily graze the green clover when turned on it during the early spring before the pasture grasses such as Bermuda and buffalo start growth. As the plants begin to toughen, however, Hubam is not so readily grazed by stock if any other forage is available.

The Blackland Erosion Experiment Station, near Temple, Tex., is carrying out tests with Hubam to determine its place in the cropping systems for the Blackland region. The studies have not been run for a sufficient time for the officials to define definitely its possible values or its limitations.

Because of the increasing interest of farmers in this clover, it has been generally planted during 1938 and 1939 within the communities having C. C. C. camps or S. C. S. projects. Some farmers who have grown the crop are not enthusiastic about its value as a forage crop. Most growers who have been interviewed think that Hugam is much more valuable for green manure than either cowpeas or soybeans, chiefly because of the heavier growth of vegetable matter and the fact that it matures before the most active season of root-rot fungus. The protection from erosion afforded by this crop, for a relatively brief though critical period of the year, is widely recognized. As Hubam becomes better known and more generally used, it is possible that better methods will be found for handling it, and thus some of its objectionable qualities will be overcome. It is apparently the most promising legume known to be adapted, or now planted to any extent, in the Blackland area of Texas.

CUTTING AND USE OF BRUSH

(Continued from p. 86)

more effective and more permanent erosion-control values than if cut and placed on the ground. This consideration, which already has been discussed, should be kept in mind when planning for brush work, and might often result in a decision to leave brush uncut on a given area.

It should be pointed out to crews engaged in brush work that piñon and juniper trees require many years to grow brush in any considerable quantity. Therefore, it is best to be reasonably certain that the brush that is cut will do more good in the few years it remains in a gully than during the many years it would normally remain on the tree.

"We have numerous examples . . . of the disastrous results that have followed thoughtless destruction of certain animal populations. Animal life not only is intimately interrelated with plant life, but with the soil itself, and our knowledge of ecology is still insufficient for us to assume that we can afford to eliminate any species completely from our fauna or flora. It is only the part of common sense, therefore, to try to maintain the best biologic balance that may be attained under agricultural conditions." —Hugh H. Bennett.

MODIFIED PRACTICES FOR MICHIGAN'S FRUIT AND TRUCK COUNTRY

By F. E. CHARLES [1]

A STRAIGHT row of 10-year-old apple trees cannot be picked up and realined on the contour—and herein lies one of the erosion-control problems confronting soil conservationists in the fruit belt of southwestern Michigan.

It was at least 50 years ago that farmers along the east coast of Lake Michigan began turning to fruit and truck farming. Wheat, corn, oats, and rye—soil thieves—had used up much of the rather thin topsoil that centuries of forest cover had laid down over the sandy lower peninsula. Yields had dropped, from 50, 60, or 80 bushels to 10 or 15 bushels per acre. Such yields did not pay, and thus it was that farmers began shifting to the production of fruit and truck crops. The winds from the west were both warmed and cooled by the waters of Lake Michigan—cooled in the spring, they would hold back fruit buds until frost-free weather. The sandy soils were suitable for orchard and vineyard and garden vegetables; water was plentiful. Nearby Chicago, Detroit, Toledo, and Milwaukee and lesser cities would provide the markets.

Today, Michigan is in an excellent position to continue profitable fruit and garden crop production, provided the State's soil can be maintained. The markets still are conveniently near as they were 50 years ago, and demand has increased; Michigan is, in fact, next door to the Nation's center of population density. But the fruit and truck farmers have plowed and planted and tilled "on the square" until they have lost much of their topsoil, and now many rural residents are employed on a part-time basis in nearby cities. The three elements—wind, water, and sand—which in the beginning permitted fruit and truck crop production, have combined with the methods of farming to cause serious trouble to farmers through erosion. The winds blow the sand, often creating sand storms that rival the dust storms of the plains country in intensity if not in extent. Most of Michigan's water is in her lakes, but enough of it falls from the sky to cause extremely serious water erosion on the heavier, more fertile soils that are interspersed with the sandier types.

In the fall of 1935 technicians of Michigan's first Soil Conservation Service demonstration project began wrestling with the peculiar problems of the fruit belt to determine whether or not the soil deterioration could be halted by soil conserving practices. Two areas in Berrien County, totaling 35,500 acres, were chosen for demonstration, and the work proceeded under the interested observation of growers who never before had given serious thought to contour tillage as of special importance on their fruit farms.

Farms in the fruit and truck district of Michigan are small, averaging 39 acres in the northern part and 59 acres in the south. Of 875 farms, 273 are 20 acres or less in size. Farm planners must work out rotations and soil-saving practices for many fields—a half acre of asparagus, 2 acres of peaches, 4 acres of apples, a tenth acre of raspberries, a half acre of cantaloupes. In southwest Michigan there are 33 different soil types, 13 erosion classes, 23 important crops. Many of the crops are located on soil types not best suited to them—a patch of asparagus, perhaps, is established on a 14-percent slope when it should be on the crest of a knoll.

If diversified farming still prevailed in the area, contour farming could be more easily established. But with 55 percent of the cultivated land in orchards, vineyards, and berry patches, soil conservationists had to set their sights not 5 years but 25 years into the future. A farmer who has purchased or rented land worth $75 an acre, invested an additional $300 an acre in planting stock, fences, spraying equipment, labor, and fertilizer, and then faced the bills for taxes, interest, and maintenance until the first harvest—that farmer cannot destroy the progress of a decade by uprooting his apple trees to replace them along contour lines He cannot do this even though he knows that square farming is stealing more in fertile soil than he reaps in cash profits every year. Nor can he adopt any satisfactory scheme of diagonal cultivation that would approximate the contour, because that too would involve the uprooting of his trees. Fruit farmers do not take out their trees until those trees have passed the age of productiveness—25 to 50 years.

But, fortunately, fruit farming progresses with the seasons: Occasionally a few acres of vineyard are uprooted and new plants set out, and it is the same with apples, cherries, peaches, currants, and gooseberries. Moreover, farmers in the southern or Baroda

[1] Regional information officer, Soil Conservation Service, Dayton, Ohio.

area of the Benton Harbor project are still in the process of shifting from dairy farming to fruit growing. As such changes are made, soil conservationists make every effort to have erosion control practices adopted. In the course of 4 years, farmers have agreed to follow plans for establishment of conservation practices on about 7,000 acres.

Although Michigan State College long has advocated the correct use of soils, farmers in the fruit and truck crop area did not give serious attention to the matter as long as good yields were common, and in the meantime much of the topsoil was washed or blown away. Now, however, perhaps because it is easier to see mistakes in retrospect, correct land use is graudally revamping farm plans so that eventually crops will occupy suitable soil types. The State College is cooperating in every possible way with the demonstration project, and erosion control methods are to be widely used. In principle the methods are the same as those used in other States, but in practice they are often somewhat different under the peculiar conditions of this fruit and truck country.

This deviation in soil conservation practices, to fit them to the peculiar conditions of the area, was necessary especially in contour adaptations. Project technicians first thought that an orchard row should be on the exact contour—"Let each row hold its water," they said. But, as it turned out, percolation was sometimes slower than had been calculated, and overtopping caused trouble. Now, because there are times when surplus water must be accommodated, each row is given a "terrace grade." On light soils a grade of two-tenths foot per 100 linear feet has proved ample for rows up to 1,500 feet in length. On heavier soils the drop is four-tenths foot per 100 linear feet. Project manager Washington O'Brien sums it up thus: "Where once we used an Abney level, we now use an instrument and a rod."

Since fruit trees and bushes cannot be uprooted and replaced on the contour, in some old orchards diversion terraces are being "worked across the slope" and, although this necessitates the occasional removal of a tree, the loss is not serious in view of the fact that the practice aids in preventing soil washing.

Soil-building practices are being employed between orchard rows, and vegetation is being used as much as possible though not in the same way as in the Corn Belt and the cotton country. "We once thought a sod orchard stayed in sod," O'Brien explains. "But sod or cover crops require moisture, and competition for moisture usually is serious as summer comes on. That is why we use a modified sod; it may be anywhere from 10 to 90 percent of a good, dense sod—in any case it is the thinnest possible necessary to prevent erosion."

Modified sod is produced by chopping with a disk, usually about the time the grass begins to head out. Disks are set at just enough angle to tear the turf, check growth temporarily, and roughen the soil surface. By fall the grass begins to recover so that it will afford protection through the following winter and spring. In the old straight-row orchards the disk may be run both ways. In the new contour orchards, sod strips in the tree rows are never disturbed.

Contour strip cropping also must be modified in this fruit country, since sandy knolls dip and fold, and true contours would run almost in figure-eights and spirals. Thus, field stripping has been resorted to as a modification, but in longer rotations. This constitutes a compromise between farmer and nature, and it is decidedly preferable to breaking up all the slopes from top to bottom.

The modified strip-cropping plan used on E. W. Lindahl's field is interesting from the point of view of rotations. The plan as shown below was worked out 3 years ago by Gus Thorpe who is now area conservationist:

	1st year	2d year	3d year	4th year
Strip 1	Truck *	Truck *	Sweetclover	Sweetclover. *
Strip 2	Sweetclover	Sweetclover *	Truck *	Truck.*
Strip 3	Truck *	Truck *	Sweetclover	Sweetclover. *
Strip 4	Sweetclover	Sweetclover *	Truck*	Truck.*

* Rye used as winter cover.

Lindahl's field is sandy and much more regular as to contour than is much of the land of the area. The rotation calls for 2 years of truck and 2 years of sweetclover, with rye for winter cover in all instances when the land would otherwise lie unprotected following maturity of a summer crop.

Terraces have been tried out in considerable variation. "We believe that terracing conserves more moisture for the trees when they are set on the terrace ridge," Mr. O'Brien explains. "This moisture is a vital necessity on the more droughty soils which are rather extensive in the project area. Where orchard conditions and sites demand clean cultivation, terracing is the best method of controlling erosion and conserving moisture. The chief problem is terrace maintenance. Often, on the more sandy soils there is as much soil loss as there is run-off, pound for pound; this is especially true in southwestern Michigan where intense summer rains cause terraces to become plugged with sand fills so that frequent maintenance is required."

(*Continued on p. 96*)

Enrollees of the Soda Springs camp, building contour furrows on Darland Mountain to hold run-off water on a badly trampled sheep runway.

HUSBANDING SOIL, GRASS AND WATER ON THE AHTANUM CREEK WATERSHED

HOW TO CONTROL EROSION and conserve water under the conditions peculiar to the Ahtanum Creek watershed west of Yakima, Wash., since 1935 has been the subject of joint demonstration by the Soil Conservation Service and the Soda Springs C. C. C. Camp. The camp has recently moved to Waterville to engage in similar work there.

An inventory of the distinctive accomplishments on the drainage area of Ahtanum Creek accords first importance to the better protection of the watershed from which farmers along the creek obtain irrigation water and on which they graze their cattle during the summer. Hardly less noteworthy is the protection of creek banks where camp enrollees effectively checked the washing away of the rich soil in hopyards and orchards.

Most cooperators along the creek belong to the Ahtanum irrigation district, through which the watershed range improvement program was developed up in the Darland Mountain country 10 to 20 miles away. These farmers will continue their active efforts on behalf of better land use. The Service has established an area operations office at Yakima to direct field activities in half a dozen counties.

Back in the Soda Springs country, in the Green Lake and White's Pocket regions, 32 miles of drift fence were built to enable grazing to be managed for the permanent protection of these eastern Cascade foothill slopes. Thousands of feet of contour furrows and water spreaders to hold water on mountain meadows do their part to stabilize the summer supply of water that flows into the Ahtanum Valley ditches. In the valley additional thousands of feet of bank revetment, and rock-wire jetties, help to hold the stream to its course during high water, and keep the soil from washing down the creek.

More than 26,000 acres are involved in the conservation development, some 23,000 acres comprising the upper watershed work.

At one time, thousands of cattle, sheep, and horses were run on the Ahtanum watershed. Finally, both Soil Conservation Service and local ranchers agree, overuse took off the protective natural vegetation to such a point that quick run-off in the spring was followed by earlier irrigation-water shortage in the summer. In the early 1920's, a consistent reduction of stocking was begun under direction of the State land commissioner, but further refinement of the managed grazing program remained to be done when the C. C. C. camp was located there.

Service technicians found the range had suffered from premature grazing in high elevations and from

heavy overgrazing near salt ground and areas of choice feed. Wallace Wiley, member of the irrigation district and of the local Cattlemen's Association, is authority for the statement that at one time "there were more sheep on the upper end of Ahtanum than are in the whole county now." Fires added to the damage from overgrazing.

The C. C. C. program was developed under agreement with the State of Washington, which owns alternate sections, a railway company which holds odd-numbered section grants, and the Ahtanum irrigation district, which purchased some 8,000 acres in the watershed. The range area was divided into a dozen or more pastures, so that the cattle—only 625 head now—can be split into small bunches and grazed progressively over different sets of pastures through the summer season starting June 15. The drift fences were built of poles from nonmerchantable timber, connecting with natural barriers wherever possible.

The subdivision of the range, with carefully figured carrying capacities, permits proper use of the lower pasturage without grazing higher areas until the grass is far enough along to be pastured without damage. Provided in each pasture are new salting grounds removed from points of overgrazing or congregation. Although springs supply adequate water over most of the upper area, several small stock water dams were built to store snow water for summer use. Beaver dams also aid in holding water upon the watershed. The animals were trapped lower down the streams where they were damaging trees in farming sections and placed upstream where dams were needed. This program was in cooperation with the State game commission.

No logging operations are carried on now in this part of the Ahtanum watershed. Nearly 400 acres of trees were planted by camp workers. The enrollees also completed the Soda Springs-Darland Mountain Road, so that it now is more useful for fire protection and other purposes.

As stated by Judge John H. Lynch, secretary of the Ahtanum irrigation district: "We had better water in the valley last year than at any other time since 1916."

MODIFIED PRACTICES FOR MICHIGAN'S FRUIT AND TRUCK COUNTRY

(Continued from p. 94)

In an area so intensely cultivated, attention given to farm wood products naturally is at a minimum. Because of their large investments in the land the people of Berrien County feel that they cannot wait for forest trees to grow. On the other hand, there are two very good reasons why trees should have a place in the erosion control program of the area. First, these farms have constant need for wood products; fences must be built, trellis posts must be available for the vineyards, lumber and fuel always are needed. In the second place, Berrien County is spotted liberally with "blow-outs," and a soil blow-out is as serious in Michigan's fruit section as it is anywhere else. When sand begins to blow it is difficult to bring it under control. Farm woods have proved that they can do the job better than anything else.

What do cooperating farmers think of this program—farmers who have $10,000 to $15,000 investments in 40-acre farms?

Two years ago, Ben L. Sill set 5 acres of peaches on the contour and with proper cover crops between the rows he has stopped erosion, even on slopes up to 14 percent. "I am going to plant more peaches next spring, and they will be on the contour," he declared, and, later, working in his berry patch, Mr. Sill pointed out damage to the soil between straight rows from a heavy rain: "These plants will come out next year, and the peaches will bend around the hill to connect with other contour rows. Raspberries, too, will be on the contour." In an adjoining orchard, Mr. Sill's son was planting a cover crop and complaining that "it should have been done earlier." The date was July 19.

Not far down the road, Emerson Cryan pointed to strip cropping on the far side of his "eighty." He was emphatic when he declared "I have no objections to it. It is just as easy as the old way, and I think the horses know every curve. They could follow the rows with their eyes shut. Besides, there is an advantage in carrying out the tomatoes: We merely drive the truck into the meadow strip and carry out the tomatoes, both ways from the middle. We used to have to move the truck in the patch."

Cryan's farm is an excellent example of correct land use. A flat, high hill is in orchard; the sharp slopes and knobs, where the land breaks away, are in permanent pasture; and the gentler lower slopes are in a 6-year rotation of tomatoes, corn, and 4 years of alfalfa. Flat bottomland is utilized in a 3-year rotation of corn, small grain, and clover. Mr. Cryan himself relocated his fences to run on the contour.

The cases of Mr. Sill and Mr. Cryan are average for the area; there is, in fact, a high degree of satisfaction

(Continued on p. 99)

FOREWORD

Mr. McAtee needs little introduction to a Soil Conservation Service audience. From the inception of field operations on the old Coon Creek project in Wisconsin down to the issuance of this number of our magazine, he has manifested the liveliest interest in our activities and has contributed in every way possible to the solution of our problems. He has inspected soil conservation work on the Coon Creek project, on the Navajo Reservation, and on several projects in the Southeastern region. He is personally known to many of our staff members in the field as well as to those of the Washington office.

Nevertheless, even at the risk of repeating what already is well known, we should like to point out that aside from the reputation Mr. McAtee has won during his 30 years' study of the economic relations of birds, he also is widely known through his philosophic writings in the field of evolution. It would be difficult to find in America one who can speak with more authority on the subject of biologic balance.

Therefore, with keen satisfaction we announce that we have been successful in persuading Mr. McAtee to amplify for our readers the principles which we sought to present in the recent wildlife issue of SOIL CONSERVATION.

ERNEST G. HOLT,
Chief, Biology Division.

BIOLOGIC BALANCE ON THE FARM

By W. L. McATEE [1]

BIOLOGIC BALANCE is the term heard today for what yesterday was called the balance of nature. Some would assume that the primitive balance of nature such as obtained in America in precolonial times has been destroyed by civilized man and under his domination cannot return, and they would therefore deny the present existence of any kind of balance. It may well be that in their assumption they would be correct, for in all probability man's abrupt and wholesale remodeling of the landscape and his ruthless interference with its plant and animal inhabitants never can be assimilated into nature's more deliberately adjusted system of checks and balances. In their denial they would be wrong; they would have overlooked entirely *nature's power of recovery*—and it is here that the biologic balance enters the stage.

No sooner does man's disturbing influence anywhere cease than recovery begins. Unless all fertility has been swept away, bare ground soon is occupied by weeds. Grasses come in next, and if there is enough moisture they are followed in time by shrubs and trees. Cut-over woodland, if not too much damaged by fire, will produce a new crop of trees in a human generation. Practically all the deciduous forest in the eastern United States is this so-called second growth—a vast tribute to nature's power of recovery.

Where a little herbage is established, insects are attracted, and soon birds drop in to snap up a few of them. When the grasses and weeds produce a fair crop of seeds, mice come to take toll of them, and when there are enough mice the weasels do something about that. Juicy greens and the tender shoots and bark of shrubs draw cottontails, and enough of the bunnies attract the foxes.

None of these things happen suddenly, nor until the way has been prepared for them. They come about in a gradual and orderly manner—*naturally* in the truest sense of the word. As a philosopher once put it, "Nature abhors a vacuum," but these are hard words, meaning in the present connection only that life pushes in anywhere it has a chance. All life provides food for other life, and it is evidently a natural law that no food supply is left untouched. Further, the natural law seems to decree that while all food supplies may be utilized, none may be utterly consumed.

It is a general habit of animals to sample foods here and there; rarely do they make a clean sweep of anything. This habit contributes to biologic balance, as the toll taken is not so great but that the remainder is sufficient to maintain the food species in about their average abundance. Thus the greenery about us looks much the same from year to year; the insects dependent on that foliage neither increase nor decrease except sporadically; and birds that prey upon the insects retain their average numbers through the years.

These things speak eloquently of biologic balance, and there is a reason. Nature, while tolerant and slow, is inexorable. If a species too largely consumes its food supply, its own numbers will decrease. It may live comfortably on "interest" for years, but let it eat

[1] Technical adviser to the Chief, Bureau of Biological Survey, U. S. Department of the Interior, Washington, D. C.

into the "principal" and its own account in the bank of life soon is overdrawn.

The workings of nature's balance are evident not merely in a broad sense but also locally. In fact, natural law is the summation of local happenings. Not only is this true in logic but also in reality, for the reason that living things, as a rule, are very localized. As to plants, the condition is obvious and it is likewise true that individual animals do not range widely. Migrants are the apparent rather than the real exception, as individuals and groups keep to certain areas in both their summer and winter homes. Even their migration routes are relatively fixed. In general, territorialism rules, and it contributes a great deal toward balance.

Territorialism is the name we have for nature's system of parceling out places to live. An individual plant occupies a comparatively small territory—that traversed by its roots and branches. Usually conditions are not so uniform but that some other plant is a little better fitted to occupy an adjacent nook, whether made by vertical or horizontal variations in soil or moisture. Mixtures are the rule, pure stands the exception. Each plant draws certain substances from the soil and adds others to it, thus maintaining average fertility. To resume the banking simile, demands and repayments by each living thing are different, but in the long run a fair balance is struck.

In contrast to plants, animals seem very free moving; but even their movements are limited. The territory of a pair of small birds in the breeding season may be less than an acre in extent, and a family of bobwhites may never range more than a quarter of a mile. Mice may be restricted to a fraction of an acre, squirrels to a radius of a few hundred yards, and cottontails to from one to several acres. In general the larger the animal the more extensive the territory, but in any event it is not indefinite.

Territories seem to depend upon the degree of intolerance animals have for their own kind. When the bounds are overstepped, conflict soon results and the trespasser, as a rule, is glad to retire to its own domain. The result is that creatures are confined almost as by a fence, inside of which they must comport themselves so as not to spoil their own living. If they materially damage the range, it will then be lost to their species for a time. With such a system in operation, almost everywhere, it is apparent why natural balance usually prevails and why if disturbed it tends to return to equilibrium. Unbalance automatically brings correction.

Balance results from equalization of opposed forces, and in nature these may be conceived of as a tendency for life to remain localized and hold its place, offset by another tendency under which it spreads and fills any unoccupied habitat. The former leads to the holding of territory, the latter to pioneering, and as a result of their interweaving, the woof of life always pretty well fits the warp of environment. This is certainly balance.

The web is woven only as life is sustained by air, soil, water, and other life. In the realm of sustenance, also, balancing factors prevail. Where there is food, something will come to feed on it. If feeding goes too far, the feeders must retreat. Under natural conditions consumption is more or less in proportion to the supply and does not materially encroach upon it. That is balance.

Where encroachment is noticed, it may usually be traced to some unnatural condition produced by man. That is unbalance. Wherever there is unbalance, nature seeks to correct it. Balance, if not always evident, may be said to be ever imminent.

When a working balance becomes established, regardless of the changes, it may be at a new level, and whether or not on that level it is advantageous to man depends greatly on what he has done. If, for instance, he has practiced clean farming to the extent that there is little nesting cover for birds, sufficient cover will nevertheless remain for insects, and they will increase. Their own internal wars will produce some sort of balance, but it will be at a higher level and there will be more insect mouths to feed. The farmer will have given aid and comfort to the enemy. If he allows the fertility of the soil to fall, as by uncontrolled erosion washing away the loam, the inhospitable subsoil will support fewer and less desirable plants. Vegetation will do its best to reoccupy the land, but for a period it will be sparse and weedy and will support little animal life of value to the farm. The web of life is stretched thin to cover a barren place. There may be balance but it will be at a lower level than before. If destructive influences cease, conditions will improve slowly under nature's management, though more rapidly under man's if he will but make the effort. Enrichment instead of depletion of environment should be his conscious goal; and when that ideal steadily prevails, there will be a different, a far more satisfactory tale to tell of man's progress in getting along with nature.

The phrase "balance of nature" admittedly is a figure of speech, but it is a justifiable one. Balances always tip up and down before they equalize. The balance of nature is such a tipping balance because all animal and

plant populations are ever fluctuating. But just as truly as a weighing balance seeks equilibrium so does that of nature.

This is no more difficult to understand than is the fact that if the grass is scanty here and lush yonder, grazing animals will feed "yonder"; automatic equalization takes place at once. If sumac bushes along the edge of the woodlot are shaded out, cottontails which feed so much on sumac bark may have to leave the dying thickets and come perchance to a hedge near the garden where they may do damage. If mice in grassland are killed by burning, weasels that would prefer to feed upon mice may be forced to look elsewhere for food, possibly in the chickenyard. If some isolated, densely branched and prickly trees, as thorn apples or red haws, are preserved or grown, kingbirds will build their nests in them and from these airy castles harass crows, hawks, and buzzards, so that they no longer can do as they please. The kingbirds will also consume thousands of insects during the summer.

The operations of nature's balance are going on before our eyes at all times and to realize it we need only take a little thought as to causes and effects. Everything that happens has a cause and produces an effect, and these effects in turn become causes. The far reaching effects of a hard winter or of a drought are familiar examples. As a result of such climatic severities, trees may die at once or be so injured that they succumb later. Every tree that perishes has been host to many kinds of insects who must find another home or die. The insects have regularly paid an endurable toll to various predators and parasites which must now levy their tax elsewhere or cease to exist. The trees that die have shaded the ground but now the sun strikes through their leafless branches, stimulating to rapid growth plants previously suppressed and seeds that have been waiting, possibly years, for this opportunity to sprout, grow, and reproduce their kind.

Each new thing attracts a company of dependents, so that under the dead tree a plant and animal society very different from that previously dominant may come to rule. The lifeless bole and branches themselves provide homes and food for fungi, insects, and other organisms that could not successfully attack the tree in life. Each being in the association depends upon and prepares the way for others. This is just as true of the farm as of the woodland; a source, perhaps difficult to trace, may have a great result, though acting through a number of links in the chain of cause and effect. Such a series is like the file of wooden soldiers familiar in childhood; let one topple and down go the rest. To return to the warp and woof simile, the web of life is so involved that no thread may be added, none withdrawn, without in some degree affecting the whole pattern. No wonder then that man's usually unconsidered and ruthless alterations have unexpected and regrettable effects. Barren wastes where prosperous civilizations once reigned clearly show him that if he desires to occupy the earth in anything like present numbers, he must pay more attention to balancing factors and work with, rather than against, nature.

Observation teaches that natural balance, like good housekeeping and good husbandry, is guided by the rule "A place for everything and everything in its place." It takes every kind of place or "habitat" natural to an area to ensure the presence of all factors necessary to working of the biologic balance. The farm that keeps intact all natural nooks, and produces wildlife food and cover that is as widely distributed and abundant as is compatible with successful farming, will come nearest to attaining that biologic balance so necessary to wild creatures and so beneficial in enlisting all the aid that nature can give in maintaining the farm. In the light of the balancing principles of holding territory and pioneering, it is encouraging to the individual landholder to realize that attractive territories for numerous kinds of wildlife can be established entirely within the boundaries of his own place, that he can successfully practice wildlife management whether his neighbors do or not, and that the zeal of wildlife in finding all favorable places ensures that the territories he preserves or creates will be found and occupied.

The farmer who insofar as possible preserves natural conditions and encourages biologic balance, contributes not only to his own welfare but also to that of the Nation.

MODIFIED PRACTICES

(Continued from p. 96)

with the soil conservation program among cooperators. Of 131 agreements, not one has been canceled through disagreement or disappointment with the farm plan. Only 6 agreements have been canceled, and these by deaths or sales.

So much for cooperators. As for noncooperators, Mr. O'Brien gives us an intimation of the future of soil conservation in the Michigan fruit and garden crop area in the following brief statement:

"In the last 6 months I have noticed that a lot more farmers are asking questions about erosion control."

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

VANISHING LANDS. By R. O. Whyte and G. V. Jacks. New York, 1939.

This is the most complete treatment, in a single volume, of world-wide erosion problems yet to appear. It is especially valuable to us in that it is produced by two distinguished British scientists who know intimately erosion conditions in not one country but many, and who have followed with intense interest the details of the soil and moisture conservation work in the United States. Dr. Whyte is Deputy Director of the Imperial Bureau of Pastures and Forage Crops; he is also, as we all know, the editor of *Herbage Reviews* and it is not necessary to point out here how valuable that publication is and will continue to be to soil conservationists in this country. The second author, G. V. Jacks, is Deputy Director of the Imperial Bureau of Soil Science and, judging from his works in this volume, he is also something of a social scientist and an economist as well as a soil scientist.

The British edition of the book is called "Rape of the Earth," and was especially designed for use in disseminating erosion information and coordinating conservation work throughout the countries of the British Empire and the United States. The two authors do not collaborate on the book as a whole; 12 of the chapters are by Dr. Whyte and the remaining 10 are signed by Mr. Jacks, although it is apparent that both scientists have a thorough understanding of all phases of their broad subject.

The book treats erosion history and erosion consequences of practically all the lands of the world as a whole. European and Asian lands touching on the Mediterranean are discussed under one heading as to old and new erosion problems, and North America and South America are treated extensively as recent "pioneer" lands that have in many places suffered severe erosion and soil depletion resulting from rapid development and mechanized agriculture and as that part of the world where conservation methods have made most headway. Africa is given first place as a desiccated continent where erosion is still gaining momentum. Australia and the United States are compared in various ways and land types, and the decision of Dr. Whyte is that the rate of erosion in the former is greater than in the latter country. The Orient is treated in an interesting and unique fashion—as the place of "old age" erosion where soil misuse has had tremendous economic, political and social consequences. Japan is spoken of as the country where "erosion control has passed from an experimental science into a firmly established art" for the reason that Japan must protect her soil or end as a Nation.

Two chapters by Mr. Jacks on soil erodibility and the principles of soil conservation lead to Dr. Whyte's discussion of the agronomical practices of the Soil Conservation Service of the United States, and seven chapters deal with these special conservation problems: Reclamation of gullies; pastures, ranges, and veld; trees and agricultural conservation; dust, dunes, and deserts; water conservation and flood control; road construction and soil conservation; wildlife resources in relation to the soil and to human beings.

Mr. Jacks writes the last six chapters of the book, giving a dignified, clear, and very readable presentation of the economic causes and consequences of erosion and the political and social consequences in grassland environment, in tropical Africa, and South Africa. Some rather profound ideas are introduced in the final chapter, particularly those regarding settlement of semiarid lands and population density on any land. This chapter constitutes an excellent thought provoker for those who realize the relationships between population and the balance of soil fertility.

The fact that "Vanishing Lands" was chosen by the Book-of-the-Month Club as the outstanding book of the September lists is most gratifying to American conservationists as well as to the distinguished British authors.

WATER—WEALTH OR WASTE. By William Clayton Pryor and Helen Sloman Pryor. New York, 1939.

This might be called a "water panorama" and certainly would prove useful in the educational program of the Service. It is excellent reading not only from the standoint of the conservationist but from that of the general reader with lively interest in historical facts as related to natural resources of the planet on which we live. The theme is wise use of water; by tracing the pattern of human migration and achievement, by way of rivers, oceans, aqueducts, and plowed furrows, the authors have drawn a vivid picture of the vast subject of the great "ally or enemy," water, and its importance to individuals and nations. Chapters treat single phases of the great subject in relation to its effect on human destiny—history's highways, the rivers and the seas; water supplies for cities and why men toil and millions are spent to lay great aqueducts; water for recreation and for beauty; man's short cuts to places near and far by way of canals; water for power; the denizens of waters from the food fish to the versatile coral who can build a necklace or an island; water in mining, the ally, or water in mines, the dreaded enemy; water in the factory, the laboratory, the home.

The Pryors tell a vivid story of contaminated water, by way of India and 16,500 dead while an old Hindu custom spreads cholera, and by way of a little "inn of death" and typhoid in the United States. They point a sharp lesson when they write down for all to read the incident of the "upper middle class" people who, rather than pay small charges for the use of a town-sewage system, preferred to dump refuse into a stream that provided a water supply for a city of 25,000 other people 9 miles away. Still in story form, the authors then give us two excellent chapters on floods and flood control. The flood left a "high-water mark," on the house and in the mind of the child who "had no idea what had caused the flood." This book if placed in the hands of an eighth-grade child would be read with eagerness, and that child would learn what causes devastating floods, and that to cure the Nation of floods "a combination of remedies must be applied." Woods and forests, better designing of fields and cropping on farms, flood basin development, careful planning for future cities and towns—these flood-control methods are discussed and defined as to relative importance in curing the Nation of floods.

"So trees do us two favors: they consume water and they put brakes on the slide of water and of soil down to the sea." . . . "Levee building has been a brave effort, but it does not work for our wild Mississippi." . . . "Farms must be planted *differently*"—these are sentences taken at random. And then come two chapters on water and the land, the farm. The story of farmer William Shepherd which begins in a "little frame farmhouse in the Dust Bowl" is an inspiring story in spite of its pathos. For this farmer bade goodbye to his neighbors as they left their farm to the dust and sought the long road; he attended a meeting in the town and invited a "soil expert" to his farm. He terraced his land, he plowed according to the slope of his land, he left the roots and stalks in his fields after harvest, he adjusted his crops to his fields—he conserved the moisture and saved the soil. He and his family were happy again, within 1 brief year, because they had stayed at home and saved their land.

The authors of this book are expert photographers, and the publisher appreciates the value of fine pictures in illustrating a story about water in relation to the people. Fifty-six exceptionally fine rotogravure reproductions have a great deal to do with its being recommended here for upper-grade schools.

U. S. GOVERNMENT PRINTING OFFICE: 1939

Bulletins Reflect Role of Vegetation in Soil Conservation Work

For REFERENCE Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information, U. S. Department of Agriculture

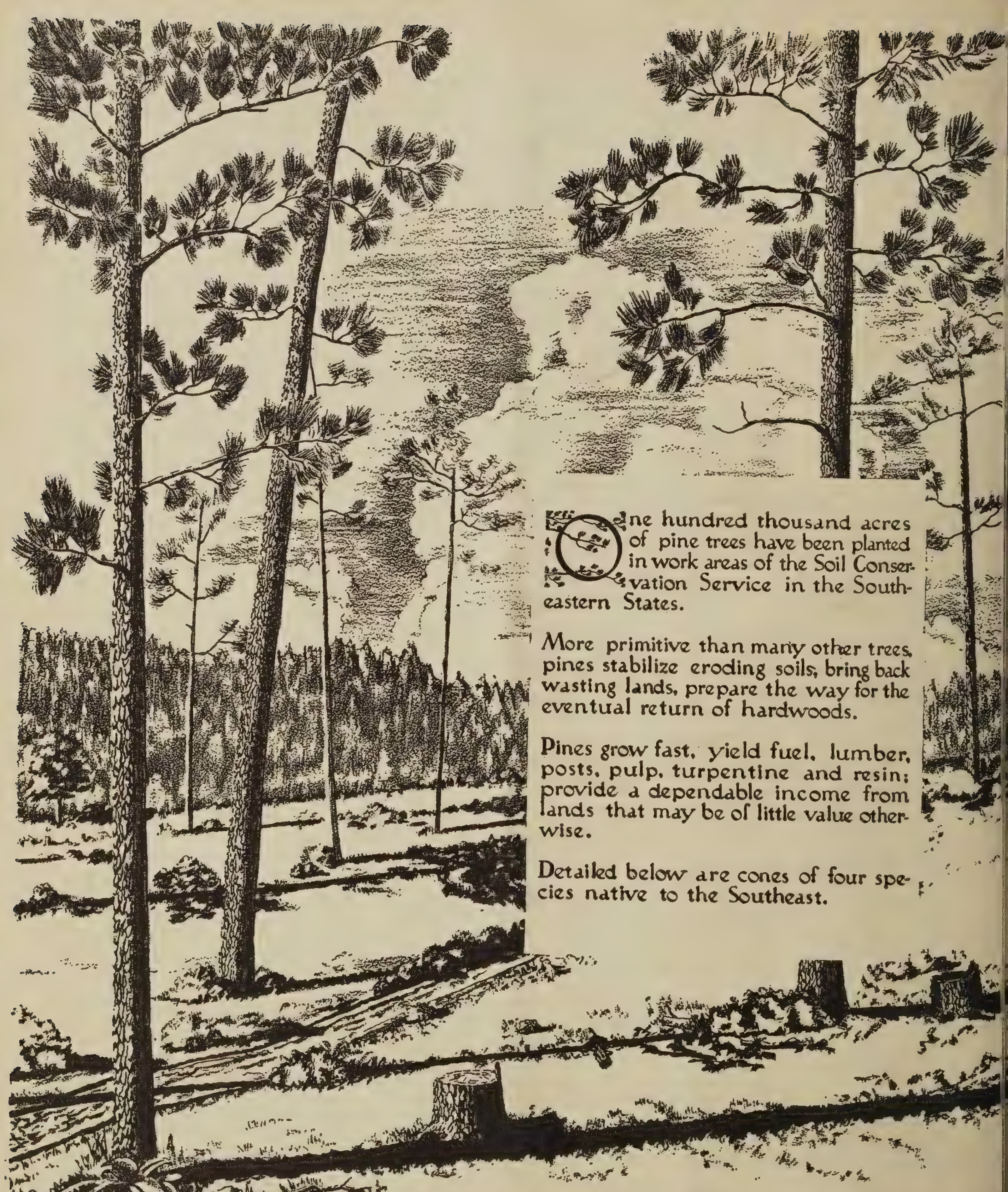
Artificial Reseeding on Oak-Brush Range in Central Utah. Circular 458. Forest Service. February 1938.
Changes in Weedy Plant Cover on Cleared Sagebrush Land and Their Probable Causes. Technical Bulletin 654. Bureau of Plant Industry. December 1938.
Crop Rotation and Tillage Experiments at the Northern Great Plains Field Station, Mandan, N. Dak. Technical Bulletin 536. Bureau of Plant Industry. December 1936.
Grass and Other Thick-Growing Vegetation in Erosion Control. Yearbook Separate No. 1641, reprint from pages 615–633. Soil Conservation Service. 1939.
Grass Culture and Range Improvement in the Central and Southern Great Plains. Circular 491. Bureau of Plant Industry. February 1939.
How To Keep and Increase Black Grama on Southwestern Ranges. Leaflet 180. Forest Service. January 1939.
The Influence of Precipitation and Grazing Upon Black Grama Grass Range. Technical Bulletin 409. Forest Service. April 1934.
Irrigated Crop Rotations at the Huntley (Montana) Field Station, 1912–35. Technical Bulletin 571. Bureau of Plant Industry. June 1937.
Legumes in Soil Conservation Practices. Leaflet 163. Soil Conservation Service and Bureau of Plant Industry. 1938.
Methods of Making Silage From Grasses and Legumes. Technical Bulletin 611. Bureau of Dairy Industry. March 1938.
Native and Adapted Grasses for Conservation of Soil and Moisture in the Great Plains and Western States. Farmers' Bulletin 1812. Soil Conservation Service. February 1939.
The Relations Between Crop Yields and Precipitation in the Great Plains Area. Miscellaneous Circular 81. Bureau of Plant Industry. February 1927.
The Relations Between Crop Yields and Precipitation in the Great Plains Area: Supplement 1.—Crop Rotations and Tillage Methods. Miscellaneous Circular 81, Supplement 1. Bureau of Plant Industry. October 1931.
Reseeding Range Lands of the Intermountain Region. Farmers' Bulletin 1823. Forest Service. July 1939.
Results of Field Crop, Shelterbelt, and Orchard Investigations at the United States Dry Land Field Station, Ardmore, S. Dak., 1911–32. Circular 421. Bureau of Plant Industry. January 1937.
Soil-Depleting, Soil-Conserving and Soil-Building Crops. Leaflet 165. Soil Conservation Service. September 1938.
Sweetclover in Corn Belt Farming. Farmers' Bulletin 1653. Bureau of Agricultural Economics and Bureau of Plant Industry. Issued January 1931, revised May 1939.
Winter Wheat and Sorghum Production in the Southern Great Plains under Limited Rainfall. Circular 477. Bureau of Plant Industry. July 1938.

Agricultural Experiment Stations

Alfalfa and Sweet Clover on Irrigated Land. Bulletin 158. Washington Extension Service, Pullman, Wash. June 1930.
Clovers and Grasses for Hay and Pasture. Bulletin 165. Tennessee Agricultural Experiment Station, Knoxville, Tenn. March 1938.
Crested Wheat Grass Practices on Wheat Farms in Four Eastern Oregon Counties. Station Circular of Information No. 203. Oregon Agricultural Experiment Station, Corvallis, Oreg., August 1939.
Cultural Methods for Winter Wheat on Nonirrigated Lands in Northeastern Wyoming. Bulletin 218. Wyoming Agricultural Experiment Station, Laramie, Wyo. October 1936.
Dry-Land Crops at the Tucumcari Field Station. Bulletin 244. New Mexico Agricultural Experiment Station, State College, N. Mex. November 1936.
Four Pasture Clovers. Bulletin 431. Vermont Agricultural Experiment Station, Burlington, Vt. March 1938.
Grasses and Legumes for Pasture and Hay. Circular 64. North Dakota Agricultural Experiment Station, Fargo, N. Dak. March 1939.
Grasses of the Hawaiian Ranges. Bulletin 82. Hawaii Agricultural Experiment Station, Honolulu, T. H. May 1939.
High-Altitude Studies on Dry-Land Grasses and Clovers. Bulletin 439. Colorado Agricultural Experiment Station, Fort Collins, Colo. November 1937.
Korean Lespedeza in Rotations of Crops and Pastures. Bulletin 360. Missouri Agricultural Experiment Station, Columbia, Mo. February 1936.
Kudzu in South Carolina: Its Value for Forage, Grazing and Soil Improvement. Circular 164. Clemson Agricultural Extension Service, Clemson, S. C. December 1938.
Legume and Grass Silage: A Survey of Methods and Results on 380 Northeastern Farms. Bulletin 305. New Hampshire Agricultural Experiment Station, Durham, N. H. April 1938.
Legumes in Cropping Systems. Bulletin 374. Kentucky Agricultural Experiment Station, Lexington, Ky. August 1937.
Leguminous Plants and Their Associated Organisms. Memoir 221. Cornell Agricultural Experiment Station, Ithaca, N. Y. March 1939.
The Liberation of Plant Nutrients From the Soil as Affected by Alfalfa. Technical Bulletin 60. Virginia Agricultural Experiment Station, Blacksburg, Va. August 1937.
The Maintenance of Crop Production on Semiarid Soil. Popular Bulletin 138. Washington Agricultural Experiment Station, Pullman, Wash. August 1927.
Pasture Plants and Combinations. Extension Bulletin 197. Minnesota Agricultural Extension Division, St. Paul, Minn. March 1939.
A Pasture Program for Tennessee Farms. Publication 217. Tennessee Agricultural Extension Service, Knoxville, Tenn. January 1939.
Save Your Soil: Establish Grass on Dry Land. Circular 124-A. Colorado Agricultural Extension Service, Fort Collins, Colo. April 1938.
Some Effects of Legumes in Relation to Economical Crop Production. Bulletin 596. New York State Agricultural Experiment Station, Geneva, N. Y. August 1931.
Trees, Shrubs and Plants for North Dakota Farmsteads. Circular 67. North Dakota Agricultural Extension Service, Fargo, N. Dak. Revised May 1937.
Trees, Shrubs, and Vines at the North Platte Experimental Substation. Bulletin 310. Nebraska Agricultural Experiment Station, Lincoln, Nebr. July 1937.

Miscellaneous

Trees and Shrubs as Soil Savers. Bulletin No. 4. State Soil Conservation Committee, New Brunswick, N. J. February 1939.
Crops for Safe Farming. Agricultural Committee, American Bankers Association, Madison, Wis. 1936. 30c.

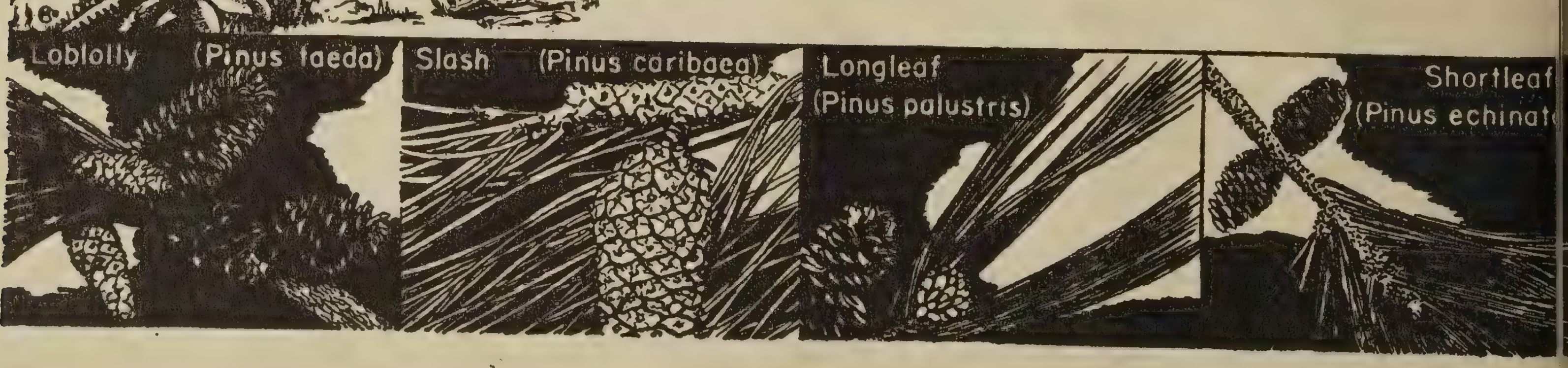


One hundred thousand acres of pine trees have been planted in work areas of the Soil Conservation Service in the Southeastern States.

More primitive than many other trees, pines stabilize eroding soils; bring back wasting lands, prepare the way for the eventual return of hardwoods.

Pines grow fast, yield fuel, lumber, posts, pulp, turpentine and resin; provide a dependable income from lands that may be of little value otherwise.

Detailed below are cones of four species native to the Southeast.



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

Vol. V· No. 5

THIS ISSUE PRESENTS~

Remarkable photographs of a raindrop as it strikes the soil.

An explanation of the new wheel charts for agronomic uses.

A step-by-step method of making willow mats for streambank protection.

Nine authoritative articles, two regular departments, a pictorial presentation of water facilities for the arid and semiarid West.

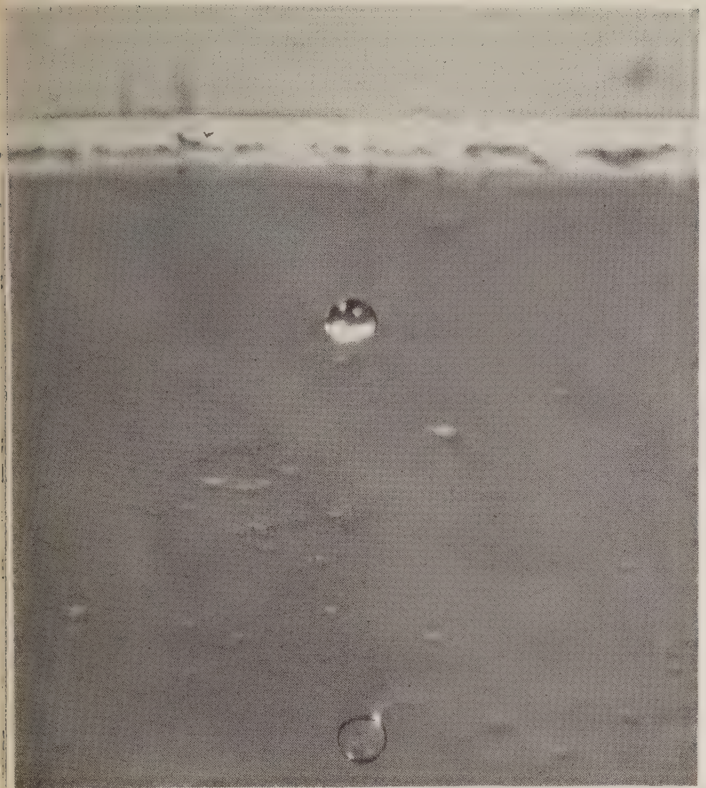
NOVEMBER 1939

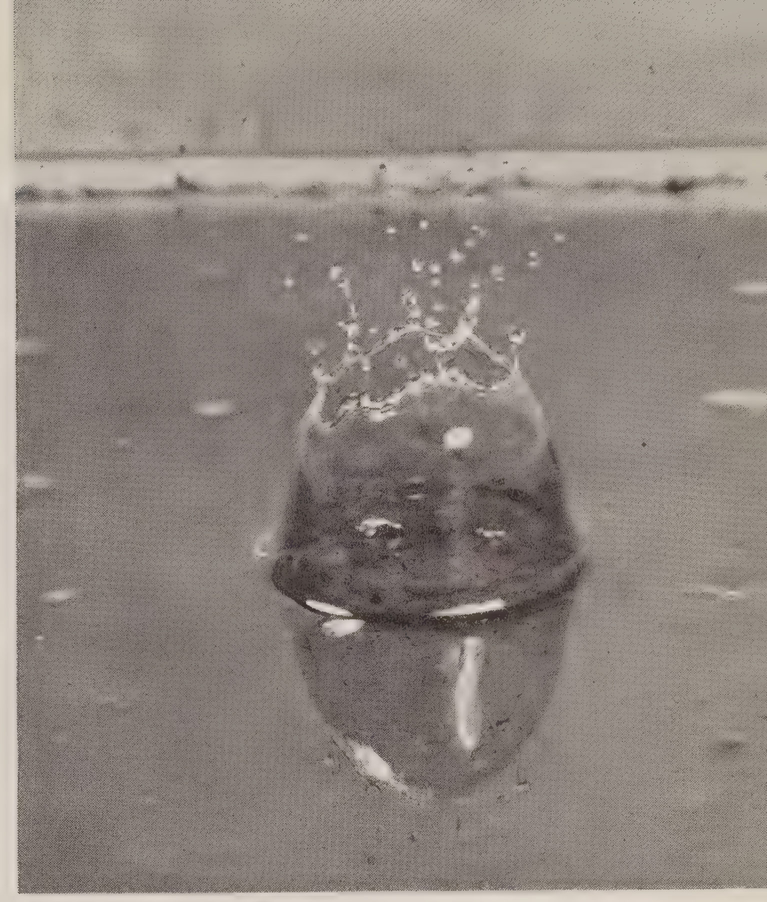
Contents

Front cover by Adrian Clem
Back cover by C. E. Margraff
Center spread by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.





THE CAMERA "STOPS" A MOVING OBJECT

by J. Otis Laws

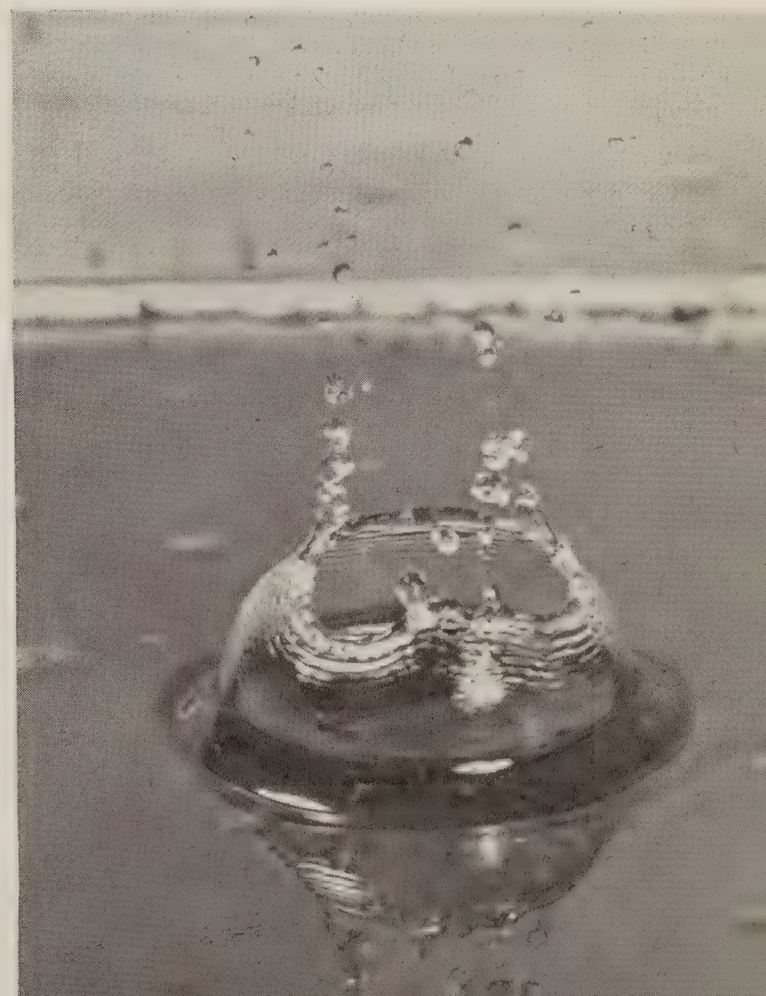
The action of a drop of rain upon striking the soil has been made the subject of a photographic study in which the high-speed apparatus of Edgerton, Germeshausen, and Grier of the Massachusetts Institute of Technology was used.

Two different techniques were employed in the study. With the Edgerton stroboscopic camera, photographs were made at the rate of 1,100 and 660 per second on a 35-mm. film. The pictures showed the whole process in minute stages and thus are valuable in observations of raindrop action. The second technique employed a 9 by 12 still camera and the Edgerton "single flash" lamp, and because of the greater amount of light and the larger film, photographs of superior pictorial qualities were obtained.

Nine series of pictures were taken with a stroboscopic camera, representing drops striking three soils and three moisture conditions. The soils were Georgia Kaolin, Vernon very fine sandy loam, and Cecil clay loam. The three conditions were air-dry, wet, and flooded.

The photographs taken on the 35-mm. film with the stroboscopic camera made possible a detailed study of a phenomenon, the results of which have recently been observed experimentally. It has been determined that the disturbance of the soil surface by the beating of large raindrops is accountable for a significant portion of the soil eroded from bare surfaces.

The techniques used in this study are applicable wherever rapid motion obscures the details of the phenomenon being examined. The exposures possible with this apparatus are sufficiently brief to "stop" even rapidly moving objects. The duration of the exposures used in making these photographs was about 1/200000 second.




A 45- to 50-year stand of Virginia pine, showing understory of hardwoods (dogwood, sweet gum, black oak) about 17 years old. Lehigh soil.

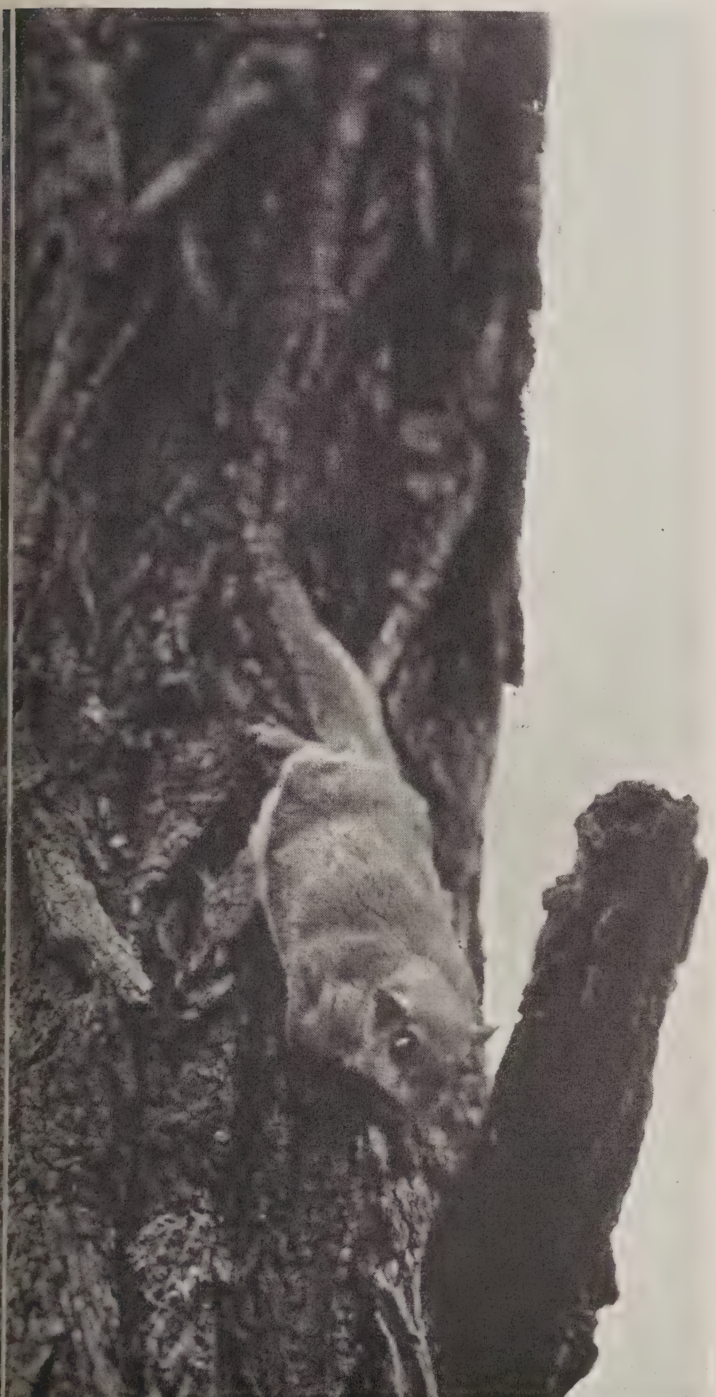
(See article beginning on opposite page.)

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 5 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON NOV. • 1939



Small eastern flying squirrel.

SOME IMPORTANT TIMBER TREES AND WILDLIFE

By WILLIAM R. VAN DERSAL [1]

THE important part played by forests and woodlands in the production of wildlife has been a matter of common knowledge ever since man began to hunt. It fortunately is true also that properly maintained wildlife populations have an important beneficial effect upon the forests and woodlands they inhabit. In particular, the relations between insectivorous birds and mammals and forest pests have been much studied, and it is now known with certainty that while wildlife is unable to cope with sudden and spectacular outbreaks of forest insects, its continued repressive action upon them is of fundamental value in the maintenance of healthy stands. It is increasingly recognized, too, that forest wildlife can provide additional and subsidiary annual income—a point of some interest when account is taken of the length of time required for timber to reach marketable size. In other words, from an economic as well as biological standpoint, wildlife is an asset to the forest which in turn provides it with a place to live.

It has been shown that the treatment of existing wooded areas for purposes of soil and water conservation enhances the value of forest habitats for wildlife. In addition, recent studies indicate that there is no operation that is silviculturally sound which cannot influence wildlife to advantage if properly used. It is now clear, in fact, that forest values whether for timber production, wildlife, or soil and water conservation, fluctuate as one and that the total worth of a forest depends on the maximum expression of its several values.

[1] Biologist, biology division, Soil Conservation Service, Washington, D. C.

In the proper management of existing forest, no less than in the development of new plantings, the wildlife aspect has received increasing consideration in the past 10 years. Relations between various systems of silviculture and wildlife populations are being studied. Much already has been learned of the wildlife values of woodland margins, of variety in stand composition, den trees, variety and luxuriance of understory trees and shrubs, and the like. Relatively little has been written, however, of the importance of the timber trees themselves, especially in relation to the wildlife food supply which in the final analysis must limit the kind and quantity of wildlife that can exist in any given habitat.

In accumulating records on the use of plants by wildlife as mentioned in the literature or supplied by the Biological Survey, it was soon learned that many forest trees may constitute an ofttimes important source of food supply for many wild species. The records, in fact, seemed of sufficient interest to deserve brief review, and are considered here in relation to trees of outstanding importance in timber production and soil conservation. Incidentally, no attempt is made to evaluate the damage done by excessive numbers of wildlife resulting from human misuse of one type or another. It is of course well known that unbalanced wildlife populations can cause considerable local damage, but it also seems reasonably clear that where proper biological and silvicultural practices are in effect such damage may be substantially reduced.

Pines

The pines comprise the largest genus of the conifers, and are probably the most important group of timber trees in the world. From the point of view of lumber production in this country pines rank first, supplying as they do nearly one-half the total wood cut in the United States each year. They have been very successfully used in soil conservation plantings, outranking in numbers planted any other genus of woody plants. The distribution of the group is widespread in the United States, one or more species being found native in every State in the Union except Kansas, and in many States a number of species are present. California, for instance, has 17.

With such a far-flung range and constituting such great forests, pines should stand high in records of utilization by wildlife. Such is actually the case, as more kinds of wildlife feed on pines than on any other genus of trees except the oaks. At present a total of 134 birds and mammals are recorded as having eaten some part or other of a pine. For many of these animals the pines furnish an important supply of food, and often are highly relished or preferred to many other types of food. The seeds of the pines are more commonly eaten than other parts of the trees, and are a staple for many birds and mammals. Staminate and young pistillate cones probably are next in importance, followed by buds, needles, and bark. Every part of a pine above ground may serve as food for one or more kinds of animals.

Pine seeds are particularly palatable to crossbills, finches, grosbeaks, jays, nutcrackers, siskins, quail, and woodpeckers. Among game birds, five kinds of quail, nine kinds of grouse, the ring-necked pheasant, band-tailed pigeon, mourning dove, greater prairie chicken, ptarmigan, and wild turkeys have been known to utilize pines in their diets.

For mammals, the pines apparently are of greatest importance to certain mice, squirrels, chipmunks, deer, and porcupine. There is little doubt that all squirrels and chipmunks will use pine seeds where they are available, although present records include no more than 16 kinds of squirrels and 11 kinds of chipmunks. It is interesting to find that records include utilization by bears, foxes, snowshoe hares, cottontail rabbits, mountain sheep, elk, opossums, and even coyotes, although there is reasonable doubt in some instances as to whether the use was more than casual or accidental. Present records show the piñon pine to have been utilized by 21 kinds of wildlife; northern white pine ranks second with 17; ponderosa pine is third with 14, and lodgepole pine fourth with 13. Very generally speaking, the widest ranging species of pine appear among those known to have been utilized by 10 or more animals. Pines of more limited distribution are utilized by less than 10 animals, with the exception of piñon pine.

Douglas Fir

Second in importance from the standpoint of timber production, and ranking high for soil conservation planting within its range, is the Douglas fir. This tree, which has been variously treated as from 1 to 12 separate species, occurs on the 2 great western mountain ranges—the Cascade-Sierra Nevadas and the Rocky Mountains—accompanying them from north to south and from sea level to rather considerable elevations, especially in the southern mountains. In its Pacific Coast form, this tree is second in height only to the giant sequoias of California; in the Rockies it seldom grows taller than 130 feet.

Records at present available show the Douglas fir to have been used by 18 kinds of mammals and 9 birds. These animals include white-tailed and black-tailed

deer, bighorn, chickarees, squirrels, chipmunks, elk, porcupine, grouse, and ducks. The tree ranks among the first 25 woody plants of the United States in point of wildlife utilization for food. Present records undoubtedly are incomplete, not to say fragmentary, but as they accumulate, the Douglas fir will in all likelihood rank much higher than it now does.

Oaks

Third in importance in point of lumber production are the oaks, but for wildlife they rank higher than any other genus of trees. There are about 85 species of oaks native to the United States. In the West they are more commonly shrubs or small trees but in the East they are important dominant trees in most forests. Except for the northern Rocky Mountain region where they are almost entirely absent, oaks are found in all States, and for the eastern half of the country perhaps no other genus of broadleaf trees is as well represented in number of species and individuals as are the oaks.

During the past 2 years 39 tons of acorns have been collected by the Soil Conservation Service for use in erosion-control work. Of all species used, the northern red oak (*Q. borealis* and its variety *maxima*) ranks highest in point of numbers of plants used. Because of the ease of "spot planting" the acorns, rather than employing plants, use of oaks has risen rapidly within the past few years so that they now rank about third among trees used for soil-conservation planting.

Some part or another of an oak is eaten by 186 kinds of birds and mammals, as at present recorded in the literature or Biological Survey files. The acorns are eaten by a very considerable number of birds and mammals. Sprouted acorns are taken by bobwhite, squirrels, deer, and mice; oak leaves are an important browse of deer; the inner bark, or cambium, is used by sapsuckers; the bark is eaten by porcupine, the twigs by beaver, the staminate flower spikes by prairie chickens, and even the nutritious galls are utilized by several kinds of birds. The geographic distribution of certain animals such as raccoon, band-tailed pigeon, and California woodpecker has been stated to coincide with or be dependent upon the range of oaks.

There would be no point in listing all the animals that feed on oaks. A great many upland game birds depend upon acorns in fall and winter. Numerous waterfowl use them; white-tailed and black-tailed deer appear to utilize acorns wherever they are found; and the order Rodentia including squirrels, chipmunks, chickarees, muskrats, ground squirrels, mice, and rats, accounts for 72 percent of the present mammal records.

Tiny birds—wrens, titmice, chickadees, nuthatches—use them; so do peccaries and thick-billed parrots of the Southwest. Bears very often eat quantities of acorns just before they hibernate; and rabbits, foxes, ring-tailed cats, elk, skunks, beaver, and even opossums are on record as using oaks for food.

Aside from their impressive record of utilization, oak acorns are known to be a "staple" food, that is, like corn, they can sustain life for long periods in the near absence of other foods. Any staple food is believed to be of greater relative importance to wildlife than are foods of the succulent or "salad" type furnished by berries and other fruits even though these may be conspicuously relished. Oak leaves have been shown to be palatable and nutritious to livestock, provided they are not eaten to the total exclusion of other foods, and from studies available on wildlife feeding in captivity as well as the wild state it appears that wild as well as tame herbivores may profit from feed as good as oak leaves are shown by analyses to be.

Unfortunately the oak records are not as specific as could be wished. Some of the species are difficult to identify, and so most records merely show "acorns" or "oak browse" to have been eaten. In fact, 40 percent of the oaks have no records attached to them at all, as species. In other words, while there is a substantial quantity of data available to show the oaks as a genus to be of outstanding importance to wildlife, it is much less specific than is necessary to determine whether some of the 85 native oaks are of greater importance than others.

Hemlocks

The genus *Tsuga*, containing two eastern and two western species, ranks fourth in terms of lumber production. The trees are not as abundant throughout their range as are oaks or pines, although geographically they are widely distributed. The western hemlock (*T. heterophylla*) is the most important of the four from the timber production standpoint; the eastern hemlock (*T. canadensis*) is one of the principal sources of tannin. In spite of their silvicultural values, however, none of the species has been used very extensively for soil-conservation planting because their site requirements are higher than are usually found on eroded land.

Twenty different kinds of birds and the same number of mammals—a total of 40—are known to use hemlock seeds, leaves, buds, or bark in their diets. Among birds the list includes chickadees, crossbills, crows, several ducks, goldfinches, three kinds of grouse, nuthatches, siskins, and woodpeckers. Mammals are rep-

resented by bears, chickarees, chipmunks, many kinds of deer, porcupines, rabbits, a good many squirrels, and elk.

Red Gum

Enough lumber is produced from red or sweet gum to place it fifth in importance as a timber tree; the species is second only to the oaks among commercial hardwoods. This tree ranges throughout the southeastern United States, and is found on a great variety of sites from bottomland to old fields. It is able to grow on severely eroded soil and probably should be used more widely in conservation plantings than it has been in the past. In the region where it grows, however, it must compete commercially with the pines, a fact which may account in part for its relatively restricted use.

Twenty-seven different kinds of animals feed on red gum. These include finches, grosbeaks, crossbills, siskins, ducks, chipmunks, squirrels, and many others. It is ranked as a relatively important food for the bobwhite, and in season may form a large percentage of the diet of these birds, especially where the tree is abundant. Seeds are the portions most commonly eaten.

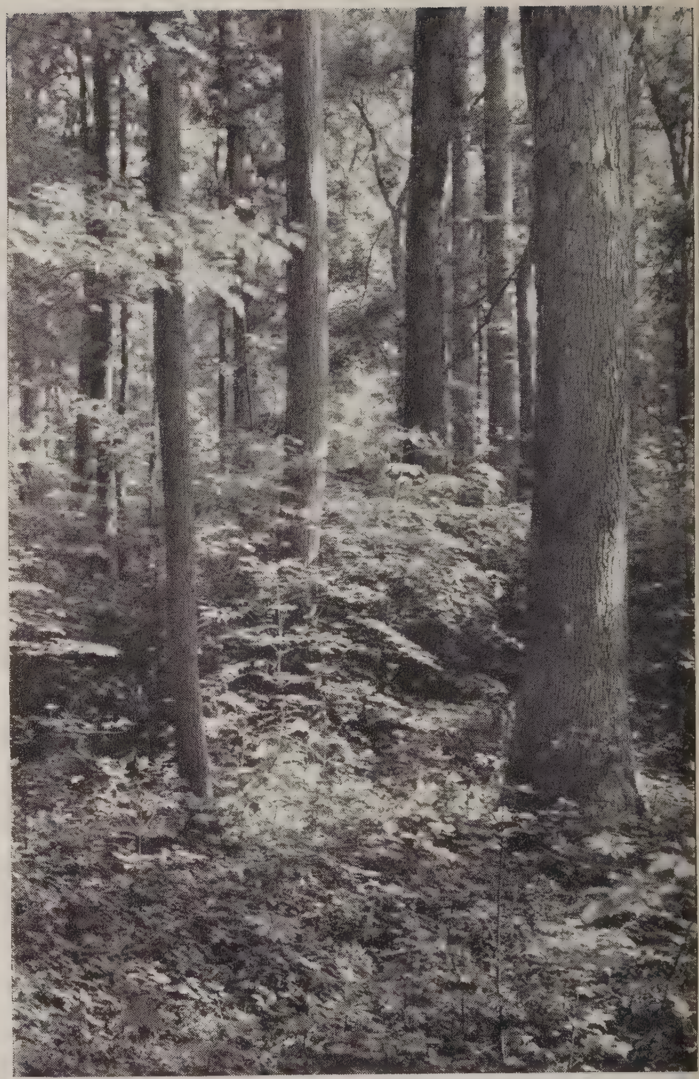
Maples

Maples rank sixth in lumber production, being third among commercial hardwoods. Sugar maple, black maple, red maple, and silver maple of the eastern United States, and bigleaf maple of the Pacific Coast, are the important wood-producing trees of the genus. Sugar maple has been used to some extent in the Northeast for soil-conservation work, and the boxelder, classed by some among maples and by others as distinct, is widely used for wind-erosion-control planting because of its resistance to drought.

Total present wildlife records for the genus amount to 47 kinds of animals. Finches, grosbeaks, pheasants, grouse, beaver, chipmunks, deer, elk, squirrels, and moose utilize the plants most commonly. The shrubby-mountain and striped maples, as well as red maple, are of considerable importance as browse for white-tailed deer and moose; in the West, the vine and dwarf maples, as well as the bigleaf maple, are similarly browsed by mule deer and elk.

Redwood, Cypress, and Spruce

Redwood and cypress have been used only in negligible quantities in soil conservation plantings, but they rank seventh and eighth respectively for lumber production. Although these trees are among the largest in the country, their available wildlife record is



Excellent stand of mixed hardwoods—oak, poplar, hickory. Most of the trees are straight. Diameters are from 12 to 30 inches. Height sometimes exceeds 100 feet. Good underbrush cover, with heavy leaf mold.

relatively small, only 2 species being recorded as utilizing the sequoias and 13 as eating seeds and other parts of the cypresses. The sequoias are restricted in range; the cypresses are restricted largely to one site. These facts help to account for the poor wildlife record as well as their restricted use in soil conservation planting.

The spruces have a more impressive wildlife record than the last two groups of trees; a total of 62 different kinds of birds and mammals are known to utilize them. Spruce ranks ninth in lumber production, the white, Engelmann, black, blue, red, and Sitka spruces being the most important. For soil conservation work spruce used to rank third but has now dropped to seventh place and may possibly go further down the list. The birds finding spruce seeds or buds particularly attractive include crossbills, grosbeaks, woodpeckers, and a great many kinds of grouse as well as waterfowl. Among mammals chipmunks, chickarees,

squirrels, deer, and porcupine apparently find acceptable the food provided by spruces.

Tuliptree and Tupelo

The tuliptree or yellow poplar of the eastern United States ranks eleventh in lumber production and tenth in soil conservation planting. Even though associated with climax trees in hardwood forests, this tree often pioneers on severely eroded areas and barren hillsides. The present wildlife record for this species is a relatively poor one, as only seven kinds of birds and mammals utilize the plant. Most of the records appear to be casual, but purple finches, evening grosbeaks, and squirrels seem to use the seeds as a regular part of their diets. White-tailed deer browse it but apparently not to any great extent.

Tupelo, including four species of *Nyssa*, ranks tenth in lumber production. One species, the black or sour gum (*N. sylvatica*), has a very good wildlife record and is also the most important wood-producing member of the genus. It is not at present used for soil-conservation planting but it ranks well up among the first 10 woody plants of the United States in point of numbers of wildlife species feeding upon it. The tree has a very wide range in the eastern half of the country and its blue-black fruits are much used by many kinds of waterfowl, game birds, and song birds, as well as bears, chipmunks, and white-tailed deer.

Chestnut and Beech

Space does not allow exhaustive treatment of all timber trees, but a few of unusual interest that rank below the first 10 in lumber production deserve mention. The native chestnut, for instance, still ranks eighteenth in lumber production although the ravages of the chestnut blight have reduced the trees to sprouting snags over most of the range. There is no doubt that chestnuts formerly were of great value to wildlife during autumn. The nuts produced so plentifully were an important food for squirrels, chipmunks, turkey, quail, and many other animals. The effect of eliminating this tree from the native flora is not clear; possibly various species of oaks may come to occupy its ecological niche. For obvious reasons it cannot be used in new plantations.

Beech, often considered of little importance silviculturally, nevertheless ranks seventeenth in importance for the production of lumber, surpassing ash, elm, walnut, hickory, and others in this respect. Its wildlife record is an impressive one, placing it among the first dozen native woody plants. The seeds, commonly referred to as "beech mast," are a principal and staple food for many squirrels, chipmunks, woodpeckers, raccoons, foxes, bears, turkey, grouse, and even deer. The fact that it is a dominant tree only in climax forests, and that its site requirements are consequently higher than are offered by eroded land, has made it of relatively little use up to the present in soil conservation plantings.

Ash, Basswood, Sycamore, and Locust

Ash, ranking in nineteenth place for lumber production has a record of use by only 20 kinds of animals. Basswood, in twentieth place, is recorded as used by 21 kinds of animals, and is of particular importance to cottontail rabbit, fox squirrel, and chipmunks. Sycamore in twenty-fifth place has a wildlife utilization record of 16 kinds of animals, although many of these records are casual.

Black locust, although not quoted specifically in recent lumber-production surveys, is interesting because of its extensive use for conservation planting. It has been widely grown in the United States and while it has not proved to be as adaptable as once supposed, it has been successfully grown on a great many sites. It is considered an important food for bobwhite, and records show its use by 13 other kinds of animals.

Quercus borealis.

THE REHABILITATION OF FAMILIES IN MAINTENANCE WORKERS UNITS ON THE PENSACOLA LAND-USE PROJECT

By WILLIAM A. ALLABAND[1]

A GREAT deal has been written on the accomplishments of development programs on land-utilization projects to reestablish productive values of submarginal lands. Not so much is known, however, of what has been done for the people who were living on these large areas of cut-over and waste land.

On the Pensacola development project of the land-utilization division, it was realized, during the spring of 1938, that while progress was being made toward rehabilitating the land, the effort to relocate suitably the families who were stranded on the land was heading toward a standstill. Acquisition operations had been started in the spring of 1935 by the Agricultural Adjustment Administration and continued by the Resettlement Administration, for the purchase of 200,000 acres of land in the northern parts of Santa Rosa and Okaloosa Counties in northwest Florida. It was intended that this area be included in a demonstration project.

The family census showed that 134 families were living on the land at that time who would be dislocated by the proposed development program. Each family had to be considered as a separate problem. The families had little in common, except poverty and dependence on the Government for subsistence. While the Farm Security Administration, through its rehabilitation division, offered financial aid to families in the form of grants and loans, to induce them to move to more suitable locations outside the project area, very few persons took advantage of the offer. This was due to the difficulty of finding new locations where assurance of permanent betterment could be given. Many families showed very little interest in moving at all. When offered the opportunity to earn the $21-a-month security wage given by the Works Progress Administration to laborers employed in the project's development program, they were quick to forget the hardships and privation previously suffered.

This general attitude was reflected in the statement of a client: "I know that I could probably find some other place where I would be much better off than I am here, because I am slowly starving to death, but I was born and raised here. I know every tree and pig path in this section and I can't bring myself to the point of leaving it. This is home."

Since the area was home to so many people, and a good home before its natural resources were depleted, the project staff began to consider a new approach to the problem: with the reestablishment of the forest, it might be possible to work out some plan for the permanent rehabilitation of these families on the land that they called home. If it could be done the final result would constitute a demonstration of land and human rehabilitation, on the same area, that would be worth duplicating on millions of acres of similar land.

It was decided that an inventory be taken of existing physical resources to determine the tangible and intangible values that caused the people to put love of home above fear of starvation. The investigation showed that in the purchase area there were many parcels of land, some of them formerly in primitive cultivation, which could be utilized for farming under more favorable economic conditions. A soils survey of a number of the parcels showed that with proper management the land could be made reasonably productive.

Furthermore, there was on the property a large number of partly completed houses—ghosts of a land-colonizing plan that had failed dismally. A French Canadian promoter in 1926 had purchased, from the lumber company which had cut the timber, some 4,000 acres of the worst farm land on the development area. By means of a glowing prospectus, amply illustrated with pictures from other areas some hundreds of miles away, he had succeeded in selling 30-acre farms to about a hundred persons of French-Canadian extraction employed at the time in factories in New England. Those people, with savings accumulated over a long period, moved in and, ignorant of local conditions, failed to recognize as impossible the land they had purchased sight-unseen. With the natural energy of their race they applied themselves to clearing the land and erecting homes and buildings on it. Before most of their homes were completed under the stress of the high construction costs pravailing in 1929, they were faced with the necessity of earning a living from the land they had prepared for their homes. It is unneces-

[1] Acting area conservationist, Soil Conservation Service, Tallahassee, Fla.

sary to go into the details of the dismal failure they suffered in return for their efforts. They readily accepted the best price the Government could offer for their homes, although it was only a fractional part of their expenditures. They returned to the homes of relatives to begin anew the struggle to make a living.

In the meantime, piles of lumber salvaged from abandoned farmsteads and lumber company structures had grown in size, with no definite plan for utilization. The partial failure of a wildlife food-patch experiment had left a large amount of fencing for which no effective use had been designated.

With all those potential assets, together with the anticipated need for a dependable labor supply for operation of the project, it was not difficult to decide that the most effective solution of the problem could be realized by the establishment of strategically located groups of maintenance-workers subsistence units. Administrative headquarters and a pine tree nursery already had been established at Munson, Fla., in the center of the area. The soils survey had shown that approximately 300 acres surrounding the site of an old sawmill were suitable for cultivation and could be cleared with a reasonable expenditure of funds. The location already had a church, a consolidated high school and a community store.

A group of farms was laid out, ranging in size from 18 to 30 acres, and each unit was completely enclosed by fence with sufficient cross fences to permit cultivation of crops and the rotation of livestock among the fields. With provision thus made for livestock production, a supply of meat was assured for family use, to supplement a small income from cash crops. A garden plot, varying in size from one-half to 1 acre, was provided on each farm unit. A similar area was arranged for double chicken runs, and an area was reserved for a house lot large enough to permit landscaping in front of the house and production of fruit in the rear. Plans were then prepared for remodeling the partially completed houses into comfortable small homes of from 4 to 6 rooms, having screened front and back porches. A deep well with a hand force pump was driven immediately behind the house site—project labor and salvaged pumps made this addition possible. A small barn with space for a mule, a cow and feedstuffs, and a standard-design chicken house large enough to accommodate from 60 to 100 chickens, were built from salvaged lumber. A sanitary pit-type toilet was established at a convenient distance from the house.

The houses to be utilized at subsistence units were moved 8 to 10 miles from their original locations—nor did they present the difficulty in moving that would ordinarily be expected. They were thoroughly braced inside and jacked up, and long timbers were placed under them. A heavy-duty trailer, regularly used for transporting the project's heavy equipment, was placed under a house and thus it could be moved rather quickly to its new site. A small crew of men often prepared and moved a house in a single day. Outside brick foundation piers had been laid at the new location before the house was moved so that the moving crew could set the house on blocks over its new location; thus, as quickly as the middle piers were laid, the house could be lowered into place.

The interiors of all houses had to be finished, front and back porches added, roofs and windows repaired, new chimneys erected, windows and porches screened, and the interior and exterior painted. The final result was a very comfortable house for the family, with privacy and sanitary conditions unknown to those who had been accustomed to living in bare two- and three-room board shacks.

After all the stumps had been removed from the fields of subsistence units, the land was plowed with a heavy fireline plow that turned vegetative growth under to a depth of 10 inches. This operation was followed by cross plowing with the same plow; and then the entire area was disked with a light gang-disk harrow to pulverize the soil for the planting of winter legumes, the green-manure crop, and oats for winter pasturage. Separate fields were seeded to Austrian winter peas and hairy vetch. Oats were planted in fields where it would not be necessary to plant early field crops. The purpose of thus preparing the soil was twofold: First, that the occupant could start his farming operations under the most favorable conditions possible, and, second, that he might be encouraged in the use of winter legumes.

By the fall of 1938, 15 of these units were ready for occupancy. Since the units had been established for project workers, it was decided that these farms be set up on a rental basis. The purpose of establishing the subsistence units was to provide quarters and limited farm facilities for permanent project employees. Under the future plan of management, these workers would be provided with part-time employment in carrying on the normal maintenance operation of the project or assisting in the harvesting of its natural resources. Thus the worker would have the balance of his time to devote to his farm operation. The proportionate amount of time to be devoted to project employment and personal farm operations would vary from month to month, depending on conditions and normal seasonal requirements. It was estimated that

the minimum annual project employment would consume approximately one-half the normal work time of these employees.

Reimbursement to the worker and the administering agency of the project, for labor and rent respectively, was to be entirely by cash settlements. Workers were to receive the same prevailing wages paid by the administering agency to other labor for like services.

The annual rental, as decided upon, to be paid by the worker to the administering agency, was not to amortize the cost of the original investment, but to obtain sufficient revenue to maintain the property in good repair and provide the necessary replacements of structures over a period of years. It might be well to state at this point that the average cost of a completed unit was approximately $2,500. Local property values indicate that comparable facilities in the surrounding section would have a market value of at least $4,000. The annual rental, figured on a depreciation basis, varied with the size of the house and the amount and quality of the land connected with the unit; it averaged approximately $3 per acre. This charge compared favorably with the average rental charge of that section of country for other farm land not incorporating the advantages offered workers on subsistence units.

It is almost unnecessary to state that the management of the project was flooded with applications from every direction before the units were ready for occupancy. Many could not be given consideration because the applicants were not residents of the project area. As was stated before, one of the main purposes in constructing these units was to solve a rehabilitation problem among families living in locations unsuited to agricultural purposes. The project manager discussed the applications with his work supervisors and with reputable citizens of the section, looking forward to the selection of the best families available from the applicants. Consideration was given to size of the family, the attitude the applicant had shown in his work on the project, conditions under which he was living at the time, his general reputation for industry and integrity over a period of years, and other general observations made by the management of the applicant and his family during the years of development work on the project.

There was very little criticism of the final selections made, and there were few disgruntled applicants. It was explained that the project hoped to build additional units over a period of years, and that it was quite possible that the less fortunate applicants would be able to secure places later. Each successful applicant was given a use agreement to sign, permitting his occupancy of the unit for 1 year, with renewal privileges to be determined mutually by his desire for another year's lease and the Government's privilege of refusal if he failed to make full use of the advantages offered him.

As is generally true of the inhabitants of cutover waste lands, it was found that all our applicants were experienced in lumbering operations and public work, but had had very little farming experience beyond that gained in the cultivation of a small patch adjacent to the house in which they lived. Their hogs and cattle had been allowed to rove in the open. Most of the families had no equipment for farming, or even sufficient household furniture to make full use of the facilities offered.

The local supervisor of the rural rehabilitation division of the Farm Security Administration had evidenced a great interest in our experiment and upon request he secured the approval of his superiors to cooperate in establishing the clients on a subsistence farming basis. He executed a 5-year loan agreement with each applicant whereby his agency lent the money for the purchase of work stock, a limited amount of farm equipment, seed, fertilizer, feed, livestock, and canning equipment. The loans varied from $85 to $300 per family according to the need as determined by the supervisor and his assistants. Loans were limited to the bare necessities required by the family to commence operations on the farm.

The applicant was expected to enter into community arrangements for cooperative use of farm equipment, and to secure other necessities from his supplementary earnings on the project. At the end of the crop year he was expected to repay a minimum of 20 percent of his original loan, and it was hoped that he would have sufficient feed and seed to finance his next crop without additional loans. The entire amount of the loan was deposited to the credit of the client with the stipulation that checks drawn for purchases be countersigned by the Farm Security Administration supervisor in accordance with a farming plan mutually agreed upon.

The farm plan anticipated the planting of a large garden for fresh vegetables and the canning of at least 400 quarts of fruits and vegetables for consumption during the winter months. It was proposed that sufficient corn and peanuts be grown to carry 1 mule, from 20 to 30 hogs, and a flock of chickens. A small acreage was to be devoted to the production of potatoes and of sugarcane for sirup. Five to 10 acres were to be utilized for the growing of peanuts for sale. Each farm plan stipulated complete utilization of the entire

area of cultivatable land in each unit. A community pasture, with improved grasses and conveniently located to all units, was made available for pasturing milk cows. A large woodland pasture comprising 700 acres provided the client with range near his unit for pasturing other stock. It was believed that the plan would permit each family to grow its essential food and meat and have a surplus of potatoes, sirup, vegetables, eggs, poultry, and pork for sale. The acreage was not so great as to prevent part-time employment on the project for supplementary income to purchase necessities.

Since it was to the advantage of the clients to purchase supplies and equipment as cheaply as possible, they soon formed a small mutual cooperative association, without charter, for the purpose of collective bargaining and to foster social gatherings for discussion of matters of interest to them. The initial membership consisted of the 15 families in the workers' maintenance units and the 5 families in lookout towermen's units, each of which had a subsistence farm connected with it. Membership was thrown open, however, to all families in the immediate section who desired to join, without the restriction of occupying Government property. Many independent farming families joined the group, which became known as the "Blackwater Cooperative Association." The president and secretary of the group received attractive bids from numerous vendors and each individual consummated his purchases at the prices quoted the group.

The purchase of fertilizer is a good example of the savings made by the arrangement: The prevailing price for commercial fertilizer in small quantities was $16 to $17 per ton, but group members were able to purchase it for a fraction over $11 a ton delivered to their barns. The project game breeder, in charge of the quail hatchery, had had considerable experience with poultry, and he encouraged all the clients to purchase 50 or more thoroughbred day-old Leghorn chicks to start a poultry flock. The chickens and the necessary feed for them was not a part of the loan made by the Farm Security Administration, but all members entered into the care of the chickens with great interest. In all probability most of the clients never before owned any good grade chickens, and most of them did not have any chickens at all when they moved into the units.

Discourse on experience of this nature could be continued, but it is felt that a brief summary of the results of the method of rehabilitation after its first 8 months of operation is perhaps more important. The families all appear happy in their new homes and evidence a desire to renew permits for the following year. The management is pleased with progress made to date and does not now anticipate refusal to renew the permits. The management of the project feels that the economic position of the clients has improved and that prospects are better than those of any of the families which were relocated outside the project area. The church in Munson, which has had meetings only at rare intervals during recent years, is functioning again. The consolidated school, which many people feared would close with the acquisition of land by the Government, is expected to continue operation.

Doubt that the clients would be able to take care of the farms and still work on the project has been dissipated by the energy evidenced by the occupants of the units during the period of heaviest farming operation in the spring. The writer has often observed men working in the fields at 5 o'clock in the morning who reported for work on the project at 7.30. After the day's work on the project, the men often worked in their fields again until dark. The people have shown a tendency beyond the average to remain at home and work on their units. Although this crop season has been most adverse, due to abnormal rainfall, crops are better than the average for the locality and, in all probability, the clients' payments on loans to the Farm Security Administration will be satisfactory. When development operations on the project were suspended for 2 months, the occupants of the units fared much better than did persons who had not been fortunate enough to receive that type of rehabilitation. One of the requirements of an occupant of a workers' unit is that he aid in suppressing forest fires on the area whenever requested, without compensation. This has proved a decided advantage to the Government and has given the worker a feeling that he is protecting something in which he has a very definite interest.

It is the opinion of the writer, therefore, that this method of rehabilitation could be expanded considerably on this project without exhausting its possibilities, and that the welfare of the families and the project will become increasingly better each year as the forest becomes reestablished and as the families provide themselves with livestock for additional income.

The true measure of success of a demonstration in multiple land use lies in its ability to incorporate the social and economic rehabilitation of the area's inhabitants into a mode of living that provides increasing opportunities for betterment within that immediate locality.

CONSERVATION PRACTICES IN PRIMITIVE AGRICULTURE OF THE SOUTHWEST

By GUY R. STEWART [1]

THE Southwest, as referred to in this article, includes the southern portions of Utah and Colorado, together with the States of Arizona and New Mexico and adjacent areas of northern Chihuahua. This country, which embraces a land with a wide diversity of topography and variations in local conditions, has also certain similarities. Throughout much of the region high summer temperatures may prevail, though on the higher plateaus, as at Mesa Verde and the Taos Valley, the elevation does much to temper the heat. Over the entire area, however, rainfall is often either deficient or highly variable so that water is the greatest limiting factor in successful crop growth. The accompanying sketch map, figure I, is divided into five main areas which, though probably not all occupied at the same time, at various periods supported portions of the highly developed primitive culture of the Pueblo people. All the tribes living in this land of desert and mesa had a unifying interest: they were sedentary farmers using a specialized maize agriculture as the basis of their successful racial existence.

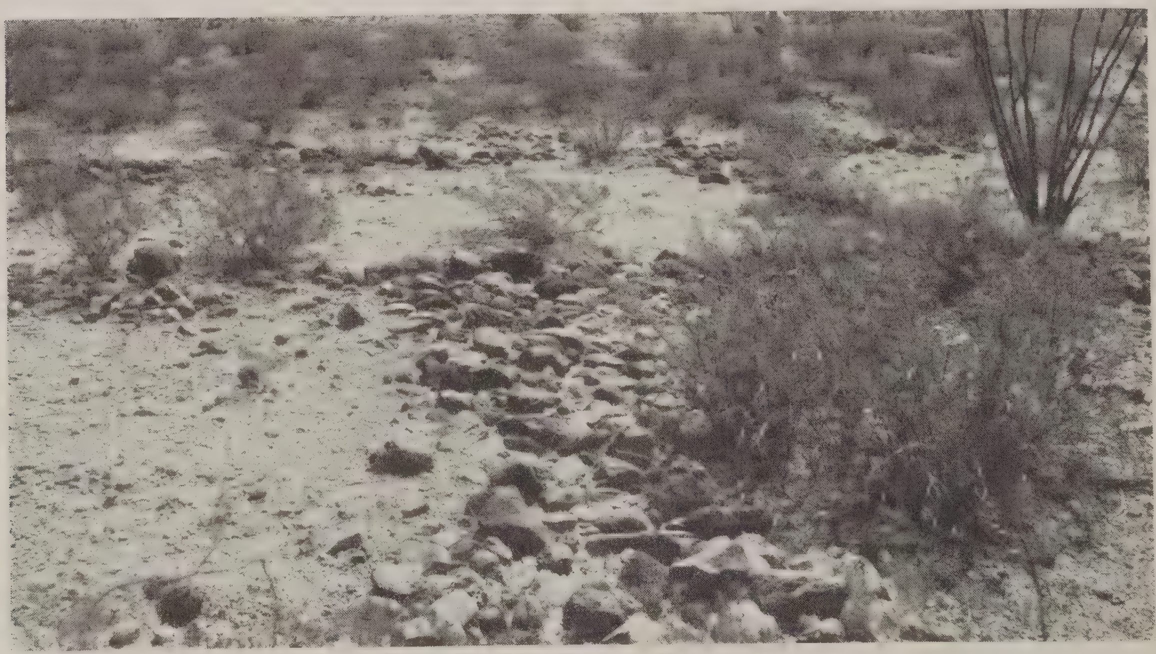
Throughout most of this country a series of stages can be traced in the development of house building and agricultural skill. These stages often are divided into several steps;[2] the people of the early basket maker culture, for example, seem to have been among the first to occupy the land, and it is known that they lived in small, separate family dwellings. The basket makers were followed by the first of the Pueblo dwellers who not only built a better type of house than did their predecessors but also advanced beyond them agriculturally by introducing cotton and domesticating the wild turkey. In the second stage of Pueblo development the people gathered in small houses arranged in little villages. Next came the period of maximum Pueblo development, the so-called classic period, when the large communal dwellings reached their greatest size. Possibly this very concentration of the people in greater centers brought with it the ills which we class as those of civilization, such as increase in communicable disease resulting from close contact and lack of sanitary knowledge, and so began the breakdown of the system of big pueblos. The fourth period, that of redistribution and partial abandonment of the large villages, was well under way when the Spaniards entered the country.

The chronology of these periods has been determined through a study of pottery types and tree-ring analysis.[3] By these processes it has been shown that the Pre-Pueblo period was prior to about A. D. 1000, while the height of Pueblo development was from about A. D. 1200 to 1400. Although the entire five sections shown in figure I are sometimes spoken of as constituting the area of Pueblo culture, the section

[1] Assistant to the chief of research, Soil Conservation Service, Washington, D. C.

[2] Early Pueblo Ruins in the Piedra District, Southwestern Colorado, by F. H. H. Roberts, Jr. Bulletin 96 of the Bureau of American Ethnology. 1930.

[3] The Secret of the Southwest Solved by Talkative Tree Rings, by A. E. Douglass National Geographic Magazine, vol. 56, p. 736. 1929.



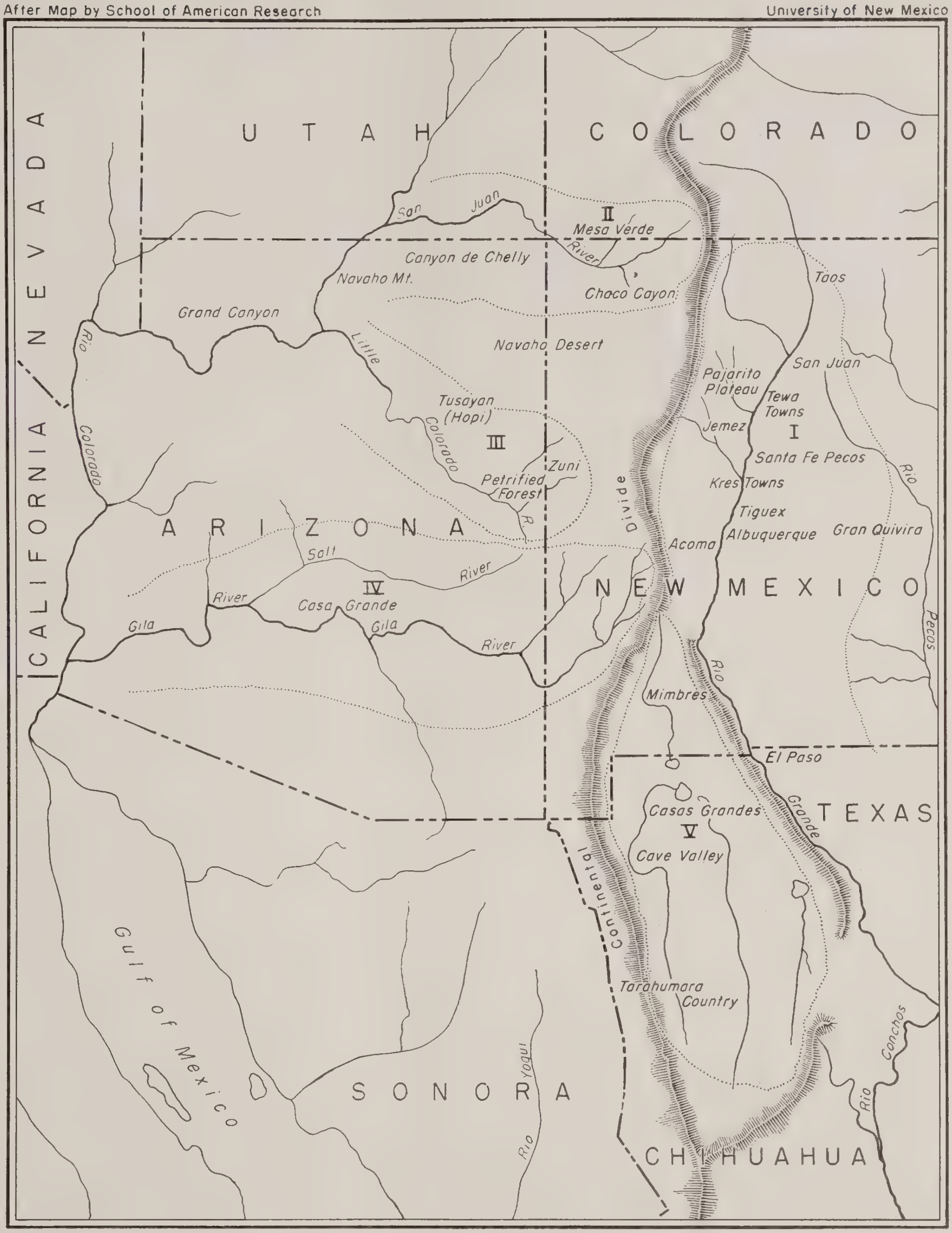
Boulder dams diverting water into rectangular plots, mesa above Peck's Wash.

comprising the Gila and Salt River Valleys is distinguished by its having had the greatest known development of a system of primitive irrigation, as shown by Turney's[4] studies. It is often spoken of as the country of the Hohokam who successfully practiced regular irrigation for a period of at least 200 years, from A. D. 1200 to 1400.

Several authors have devoted some attention to the modern agricultural methods used among southwestern Indian cultivators. The writer's interest became aroused a few years ago in trying to discover whether any consistent record could be obtained of the use of conservation measures in the primitive settlements of this region. A considerable survey of the literature has uncovered studies, by Bryan and others, of the early use of water spreading. Hewett[5] has referred in several places to instances of terracing. Sauer and Brand[6] have studied the prehistoric sites of Sonora with special reference to the occurrence of "trincheras" or entrenched hillside terraces, which they now have concluded are clearly nonagricultural. Brand,[7] however, has made other observations on an agricultural type of terrace on a large scale in northern Chihuahua. The above brief review is not intended to be complete, although the amount of study that has been devoted to methods which probably were used in primitive agriculture is surprisingly small.

MAP OF THE PUEBLO PLATEAU FIGURE-I.

After Map by School of American Research — University of New Mexico



PUEBLO CULTURE AREAS

I-Rio Grande II-San Juan III-Little Colorado IV-Gila V-Mimbres Chihuahua

During the spring of 1939 some preliminary field studies pertaining to primitive conservation practices were started, and it is hoped they may be continued as opportunity offers. Material assistance in this

[4] Prehistoric Irrigation in Arizona, by O. A. Turney. Arizona State Historian, 1929.

[5] Ancient Life in the American Southwest, by E. L. Hewett. New York. 1930.

[6] Prehistoric Settlements of Sonora with Special Reference to Cirros de Trincheras, by Carl Sauer and Donald Brand. University of Colorado Publications in Geography, vol. 5, No. 3.

[7] Personal communication from Donald Brand. 1939.

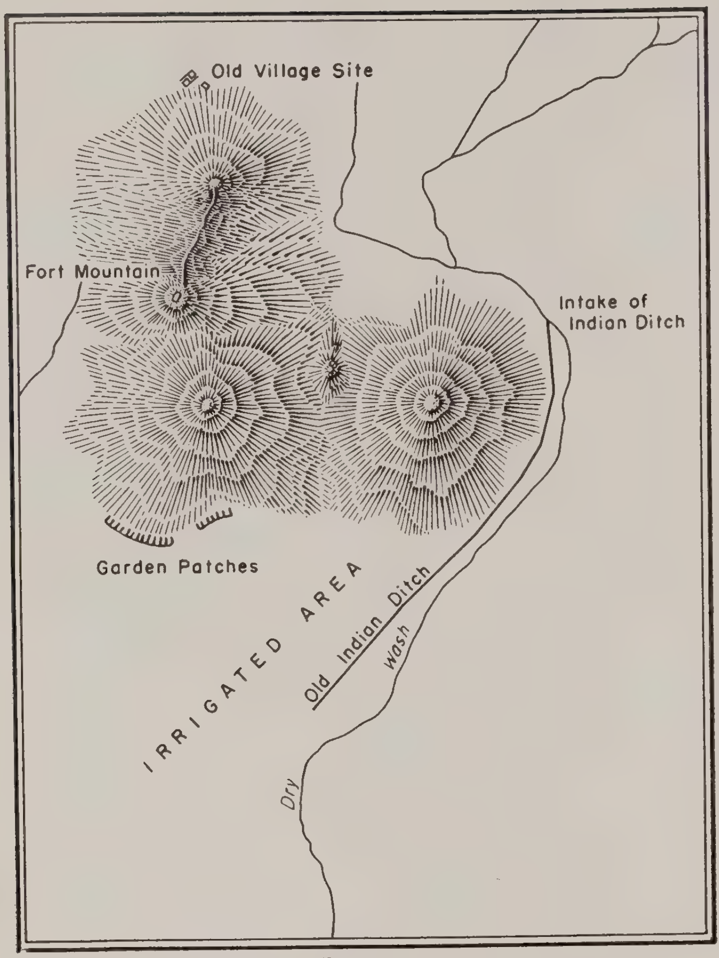


FIGURE-II.
Map of Fort Mountain Site near Cave Creek Dam, Arizona.

work has been given by friends and co-workers in the Soil Conservation Service in Region 8, as well as by a number of scientists in the Universities of New Mexico and Arizona, and by the W. P. A. Writers Project at Phoenix, Ariz.

First, a survey was made of agricultural methods employed in the Upper Rio Grande from Acoma to Taos. In general the agriculture was found to consist of an irrigation method handed down from the Spaniards and showing little early native influence.

Next, work was taken up in the Gila Valley adjacent to Safford, Ariz. On the benches above the Gila stream bed a number of interesting examples of the use of water-detention structures had been reported verbally. One of these sites, located on the bench above Pecks Wash some 2.8 miles from Pima, was examined intensively by John Cole and the writer. On this area somewhat over 25 acres is laid out, with simple water-detention boulder dams forming a complete spreading system. In the upper part of the area the detention structures were roughly rectangular in shape, varying in size from 8 by 10 feet up to 24 by 30 feet. Today there is no evident source of water for this spreader system, though it appears possible that an old washout may have changed completely the course of a former supply stream. Farther down the slope a distinct system of terraces had been laid out on a grade of 2½ to 3½ percent. The terraces varied from 14 to 18 feet in width and 180 to 225 feet in length. Soil profile studies showed that the terraces were stabilized by one line of boulders which were either matched together or overlapped.

A series of sites near Deadman's Gulch, on Graham Mountain in Arizona, was examined next. Here early terraces had been constructed, apparently by clearing the land and piling the boulders at the outer edge of the terrace. The size of the terraces was very irregular, varying from small areas of 20 by 40 feet up to approximately 30 feet wide and over 100 feet in length. Portions of this same section were examined by Dr. Haury [8] and have been dated for probable time of occupancy by pottery shards at A. D. 1200 to 1400.

A short study was made of portions of the old Indian irrigation ditches north of Phoenix.[9] Here portions of the extensive old ditch system for diverting water from the Salt River, which was mapped by Turney,[10] could still be seen. The main canals, dug by hand, were approximately 30 feet wide and 6 to 8 feet deep. The distinctive feature of these canals is the relatively level gradient which apparently necessitated the construction of branch or alternate portions of the system as the main channels filled with silt. Many parts of the banks showed the calcareous deposits noted by Haury [11] in his excavation of the Snaketown system adjacent to the Gila River.

At the northern edge of the Salt River Valley, near Cave Creek, an extremely interesting example of early agricultural practice was examined. This was the so-called Fort Mountain site shown in figure II. Here a small village was located at the base of the large hill. A refuge fort with walls 4 to 5 feet high and about 4 feet thick, made from piled-up boulders, was located on top of the hill. A simple diversion ditch, probably for flood-water irrigation, brought water from the adjacent creek and conducted it to a tract of some 30 to 40 acres which could have been irrigated easily by this means. At the base of the hill a number of simple boulder water-retaining dams were noted; by means of these dams, flash run-off could have been utilized to raise garden crops such as beans, squash, or chile peppers. At first it seemed strange that the house site was chosen on the opposite side of the hill from the cultivated area, but it was found that the best trail to the mountain

[8] Report to Soil Conservation Service, Tucson, Ariz., by Emil Haury.

[9] J. W. Simmons of the W. P. A. Writers Project, Phoenix, Ariz., gave the writer valuable assistance in finding this area as well as in locating the Fort Mountain site and other places examined north of Phoenix

[10] See footnote 4.

[11] The Snaketown Canal, by Emil Haury, University of New Mexico Bulletin 296 936.

fort led from the village up this side of the hill. When the fort was reached the entire cultivated area could be easily watched and the presence of human or animal intruders readily noted. Pottery shards dated this site at from A. D. 1000–1200.

A series of sites on New River, Upper and Lower Alkali Wash, Agua Fria Cañon, Bishop Creek, and Hackberry Wash were next visited. Here were found simple boulder terraces of varying sizes and relatively similar in design to those on Graham Mountain. The most notable departure from this scheme was the group of terraces at Bishop Creek, shown in figure III. They appeared upon examination of the profile and the scheme of construction to be of an agricultural type. The contour of the terraces varied from practically level to a grade of 2 to 3 percent with a vertical interval of 2½ to 3½ feet. The walls were of rough boulders which were still largely in place, though a few breaks had occurred. All the other terraces examined up to this time had some upper drainage to furnish a possible water supply. This was not the case at Bishop Creek. The terraces lay on the west slope above the cañon and were adjacent to the village site. At present there is no visible water supply, and it is doubtful if the rainfall is sufficient at all times to produce crops without supplementary run-off.

Collections of pottery shards were made at most of the sites visited. The collections were classified by Dr. H. P. Merra of the Laboratory of Anthropology at Santa Fe and the following approximate datings were given the sites by this method: At the New River site the pottery consisted of Roosevelt red ware of the period A. D. 1000–1200. At Hackberry Wash the pottery consisted of Salada red ware, of the same period. At Upper and Lower Alkali Wash, the pottery was again Roosevelt red ware, probably made prior to A. D. 1300. The Bishop Creek and Agua Fria sites were the most recent, yielding pottery that was manufactured some time prior to A. D. 1400.

A visit was made later to Mesa Verde where an interesting example of conservation practice was examined by Watson of the local Park staff and the writer. Here, on two branches of Soda Canyon, a series of dams had been laid up with relatively flat rock. The method of construction was notably different from anything

(Continued on p. 131)

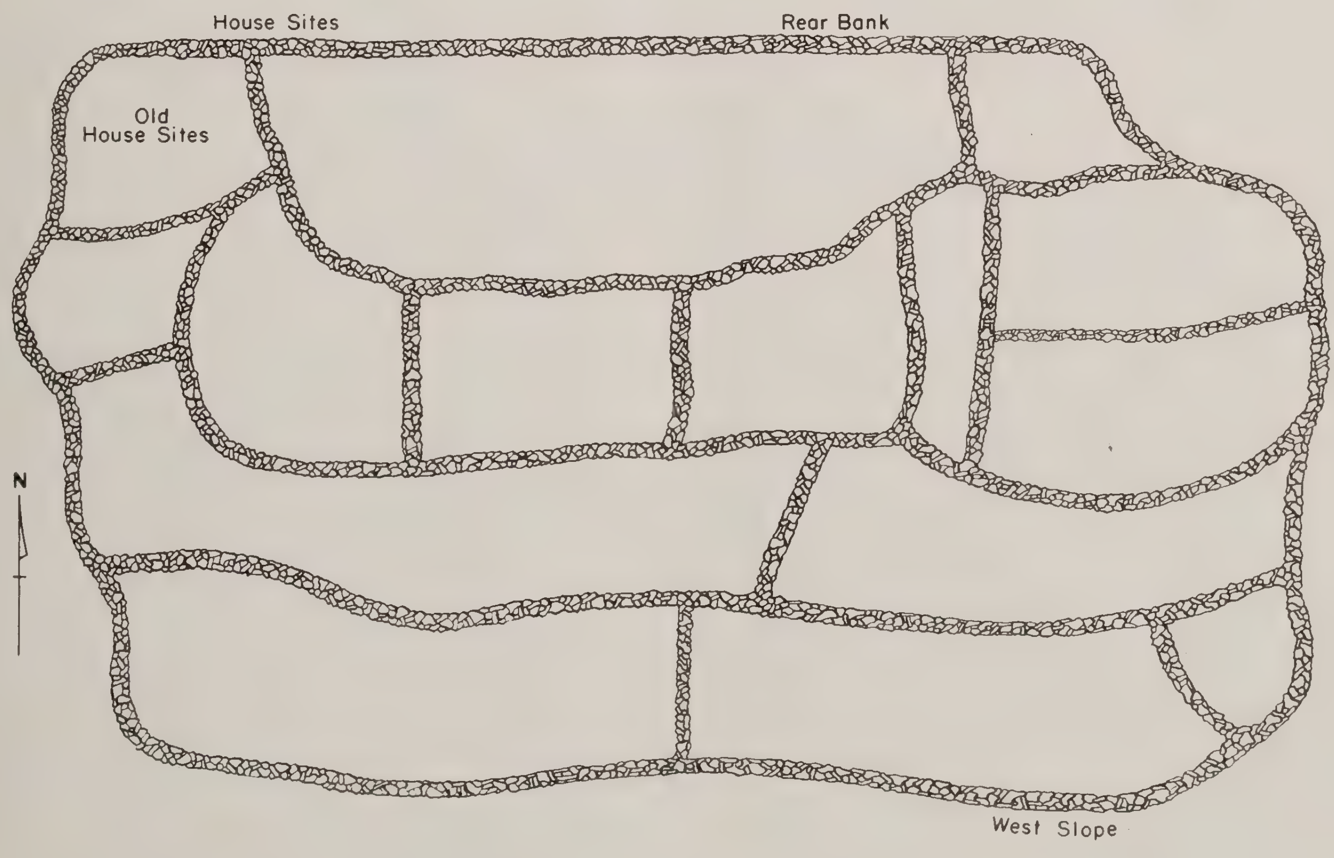


FIGURE - III.

WATER FACILITIES FOR THE

ARID AND SEMIARID WEST

WHEEL CHARTS FOR AGRONOMY

By HARRY H. GARDNER [1]

THEY eliminate mistakes, they save time and trouble, all with a simple flick of a finger.

"They" are two small cardboard discs, parts of two new charts developed at the Fennimore, Wis., project. One provides accurate information for land-use planning, and the other at a glance supplies pertinent seeding information for more than 40 crops. The charts are similar to the "geography wheels" so frequently used by school children. They have come into unlimited use at Fennimore, have ousted completely the older land-use tables.

Before the older table charts were available, each planning technician planned according to his individual opinions because he had no tabular guide. To correct that situation, in 1938 regional technicians met with field technicians in projects and developed sets of land-use tables for all work areas. The tables listed the recommended uses for all classes of land and indicated the rotation and supporting conservation practices suitable for cropland by the various degrees of slope, soil type, and erosion.

The land-use table gave the planning technician a badly needed guide based on the studies and opinions of all technicians interested in the particular work area. So successful were the tables in the projects that project technicians assisted C. C. C. camp technicians in developing a similar planning guide for each of the camp work areas.

It was found, however, that in a work area having many soil types, degrees of slope, and stages of erosion, the table became too complicated for general use. It was difficult to read the columns of an extensive table across and then from top to bottom, and these difficulties, noted at the Fennimore project, resulted in the development of the new wheel charts.

Based on soil-type, slope, and degree-of-erosion studies made by technicians of the area and the region, the wheel chart for erosion control gives the complete information carried by the old land-use tables. In addition, it provides the boon of greater convenience, as no tiring column inspection is necessary, and mistakes cannot be made. The old land-use table-chart showed recommended crop rotations and supporting conservation practices just as does the new erosion wheel. By adjusting the new wheel chart to the physical conditions represented, the technician may read quickly what land-use, rotations, and supporting practices are recommended.

The Fennimore chart is merely two pieces of paper. One of them is round—about as big as the bottom of a pie tin. The other is rectangular and about the size of an ordinary piece of typing paper. On the round piece, or disc, an arrow drawn straight from the center to the outer edge points to soil types and slopes on the rectangular sheet. Six small windows make a line across the diameter at right angles to the arrow.

In use, the arrow is turned to whatever soil type the technician finds indicated on the conservation survey map for the particular field on the farm being planned. A slight adjustment to the degree of slope existing on the field is necessary.

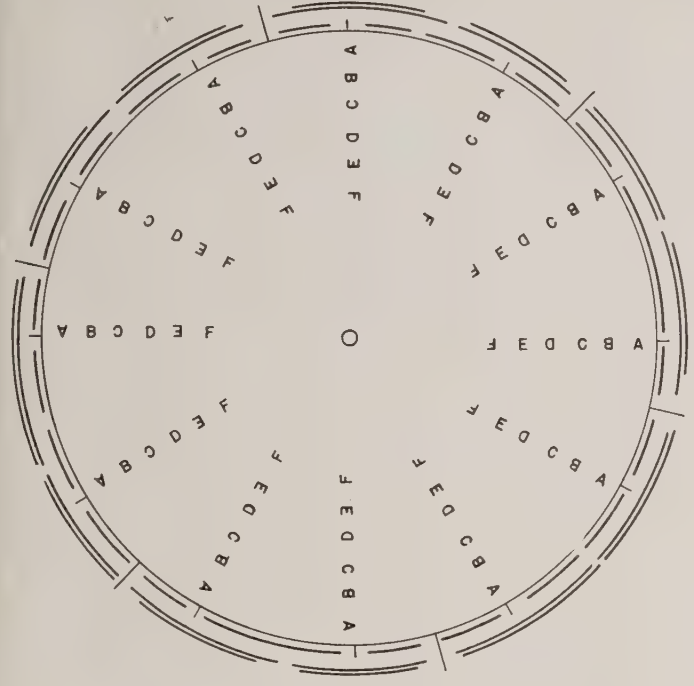
After the chart is set for the proper slope and soil type, the technician makes a finer adjustment, so that the degree of erosion existing on the field is indicated in the first window to the right or left of the arrow. The technician may then read, from the other two chart windows on the same side of the arrow, the recommended rotations and the conservation practices needed to support the rotation on that particular field.

For example, if a technician knows that on a certain piece of land the soil is Tama silt loam, that the slope is 2 to 10 percent, and that the topsoil is 25 to 75 percent eroded, with occasional gullies, the wheel chart indicates three type rotations recommended for these land conditions and that the rotation should be supported by strip cropping or terraces. The wheel chart tells him that he should plan a 6-year rotation of corn, corn, small grain, and alfalfa-grass meadow for 3 years, with a rye cover crop between the two crops of corn. Or, he may plan an 8-year rotation of corn, small grain, corn, small grain, and alfalfa-grass meadow for 4 years, with a sweetclover catch crop plowed under before the second corn crop. A 4-year rotation of corn, small grain, and legume-grass meadow for 2 years is also recommended.

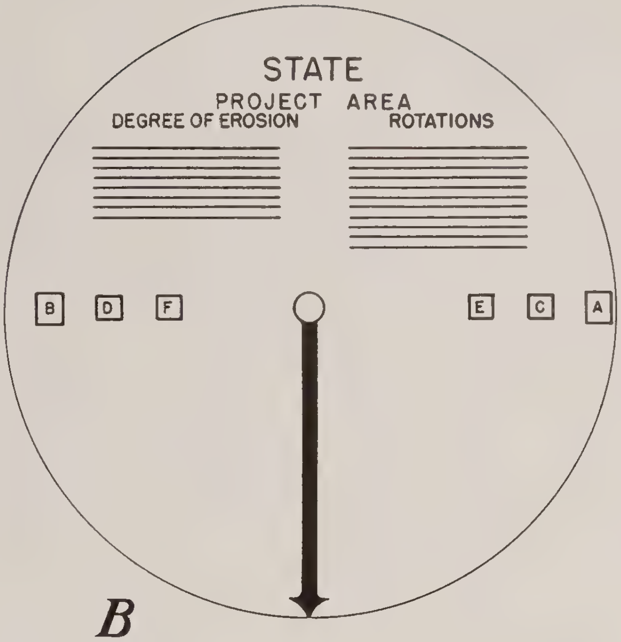
The chart does not prevent him from planning longer rotations of alfalfa and grass, nor does it eliminate the possibility of putting the land into permanent pasture or substituting winter wheat, rye, or other close-growing grain for corn.

With this basic information, the technician is prepared to consider the economic side of planning the erosion-control program for a farm. The planning technician and the farmer must agree on a rotation that

[1] Regional agronomist, Soil Conservation Service, Milwaukee, Wis.

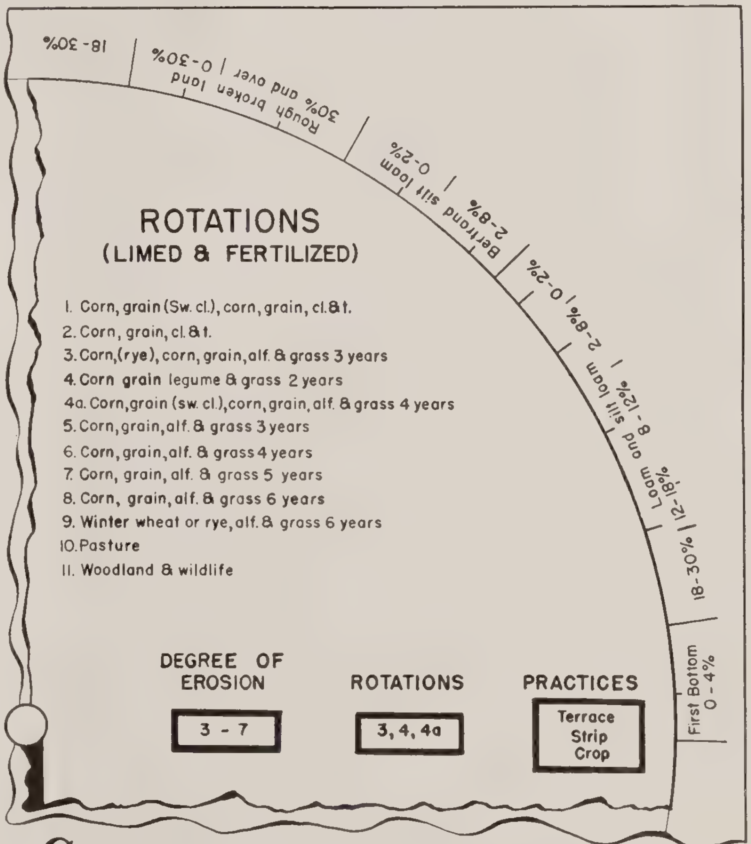


A



B

The wheel chart consists of two parts, a card designated here by the letter A, and a disc, B. On the card A, the letters represent: A and B, practices; C and D, rotations; E and F, degree of erosion. Around the circle, indicated in this sketch by short lines, appear designations of soils and slopes. The windows denoted A, B, C, D, E, F on the disc B are cut out to allow a view of the information on the card. With the disc mounted on the card so that it may be revolved around its center, the arrow is brought opposite the required soil and slope, then through the windows may be read directly the practice A and B, and the rotation numbers under C and D for the degree of erosion as seen through the windows E and F.



C

will give suitable economic return without permitting serious soil depletion. With the rotation outlined, the next thing to plan is the conservation practice necessary to support that rotation on this particular field. Here the planning technician must rely on his technical training and experience. For one set of conditions strip cropping may be the most desirable supporting practice; while for other conditions it may be necessary to use terraces or a combination of terraces and strip cropping. Contour tillage is recommended for all cropland.

The wheel chart cannot include such factors as length of slope, shape of field, location of field in relation to other fields, farm buildings, other permanent improvements, water for livestock, and many other problems that must be considered in the development of a complete soil conservation plan for a farm.

To Joe Pierre, project agronomist at Fennimore, goes the credit for this new data-presentation idea. To use his own words, "The land-use wheel chart gives identically the same information as the more complicated, more involved land-use tables. Soil type, slope, and

(Continued on p. 131)

PLANNING FOR THE SOUTHERN GREAT PLAINS

By ROY I. KIMMEL [1]

DUST storms make news, and although their damaging effects may have been exaggerated, they have served to tag the Southern Great Plains a serious problem area in the public mind.

Let us look at the facts.

Throughout western Kansas, eastern Colorado, northwestern New Mexico, and the Panhandles of Oklahoma and Texas, the average rainfall is 20 inches or less. In most other agricultural regions of the United States it is 20 inches or more—ordinarily, much more. Furthermore, it is not unusual for the rains in the Southern Great Plains region to come in torrents, when vast quantities of water are washed toward the Gulf of Mexico almost as fast as they fall.

Add to these facts the history of the Southern Great Plains for the last 60 years. It is a story of exploitation, first by overgrazing and then by heavy planting to wheat, and when the droughts came some observers expressed doubt as to whether the region could survive as farming land. There was even talk of moving the population to other parts of the country.

The Southern Great Plains contain some 97,000,000 acres, of which 65,000,000 are in pasture and 32,000,000 in cultivation. It is estimated that at least 6,000,000 of these 32,000,000 acres should go back to grass, either because they were originally and are still unsuited to cultivation or because they have been too seriously damaged to remain in cultivation. That leaves 26,000,000 acres which we now feel sure of as land that can be profitably maintained in cultivation, provided proper remedial measures are instituted.

No longer is there talk of wholesale abandonment of the area. Since 1936, when the President's Great Plains Committee made a comprehensive study of the problem and outlined a general plan of action, various Government agencies have been enthusiastically carrying out programs consistent with the recommendations. Today it can be said that substantial progress has been made toward the reconstruction of Southern Great Plains agriculture. In this work the Soil Conservation Service has had an important part.

Effort to date has been concentrated on two basic problems, (1) the elimination of wind erosion, and (2) the development of a stable system of agriculture that will bring a greater degree of security to a region where production hazards are acute.

Fundamental to the job of controlling wind erosion is that of learning to save all the rain that falls. How to do this is being shown on Service demonstration areas in western Kansas at Liberal; in Colorado at Springfield, Cheyenne Wells, and Colorado Springs; and at several places in the Panhandle of Oklahoma, northeastern New Mexico, and the Panhandle of Texas. These demonstrations, carried on cooperatively by farmers and the Service, have not only performed a useful service in showing how to control wind erosion, but also have shown that crops can be grown even in the driest years provided proper water conservation practices are used. In 1937 crops were raised on the Soil Conservation Service project at Dalhart, Tex., equaling any produced in the wettest years. In this instance the cover crop was the money crop.

Henceforth one of the principal objectives of the Service in the Southern Great Plains will be to provide assistance to soil conservation districts as they become established. The soil conservation district, as authorized by the enabling laws of the different States, provides farmers with the most effective instrument for carrying out their own program that has thus far been worked out. The Soil Conservation Service is prepared to make available to districts, once they are organized, various types of assistance. For example, the technical men of the Service who hitherto have been employed on demonstration projects will be available to districts to make conservation surveys, render engineering services, plan for erosion control, etc. Where a C. C. C. camp exists in the vicinity of a conservation district, it will be used to further the district program. Seed and planting stock will be furnished, equipment lent to carry out desirable operations. As the district idea grows, agencies other than the Soil Conservation Service will be able to contribute to the district program.

Among the other programs of the Department that will tend to prevent recurrence of wind erosion is the water facilities program authorized by the Pope-Jones Act of 1937. This program is designed to provide, through loans to producers, water facilities to both individual farmers and to groups of farmers. The type of construction ranges from pump wells for supple-

[1] Chief program analyst, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C. (Formerly Coordinator, Southern Great Plains. U. S. Dept. of Agr.)

mental irrigation to the building of small dams for stock use.

Once an area has been approved for the development of water facilities, the Soil Conservation Service has the responsibility for working out with individual farmers just what kind of facility is desirable. The Farm Security Administration provides the funds by which it is to be financed. In some instances, the Service does the work; in others, a contract will be let—the particular procedure depending upon which seems to be the most economical approach.

Wind erosion, of course, is but a symptom of an unsound agricultural economy. The second problem facing the Southern Great Plains, therefore, is that of working toward the kind of farming that gives a decent income and a better kind of life to the farmers in the region.

The initial step in the solution of this problem followed the realization by the Farm Security Administration that in large parts of the area wheat cannot be depended upon as a major source of income to the farmer. The Farm Security Administration had learned that repayments on wheat loans, with few exceptions, came from farmers who carried on a mixed type of farming. In meeting the emergency conditions of the earlier drought years, the Farm Security Administration and its predecessor had loaned millions of dollars to farmers for the production of wheat; and most of this money could not be repaid.

The Farm Security Administration now bases its policy for wheat loans on the moisture content of the soil at planting time. The soil must have a moisture penetration at seeding time to a depth of at least 2 feet before this agency will make a loan to a farmer. Certain areas with a poor history in wheat production, even in wet years, the Farm Security Administration concluded, should be allowed no wheat loans at all.

In addition, it was found that the few farmers who had been able to earn a decent living through depression and drought were, with almost no exceptions operators with holdings running into 3 or 4 sections of land. It was found, too, that most of these holdings were in grass, with the cultivated acres of the farm used for the production of supplemental feed. This and similar realizations led to the inauguration, early in 1938, of the unit-reorganization program, one of the most significant developments in the building of a sound agriculture for the Southern Great Plains.

The idea behind unit reorganization is diversified farming carried out on a sufficient acreage to ensure an acceptable income in dry years as well as in wet years.

Because in a reorganization of this kind the income during the first few years of operation is small, Secretary Wallace authorized the Farm Security Administration to extend the length of time for repayment of loans from 5 to 10 years in instances where long-time leases could be obtained. Most of the units developed have involved ownerships by four or five different persons, with the new units ranging in size from 2,000 to 4,000 acres as opposed to the unit in one section or less that prevailed in the past. This calls for, say, 300 or 400 acres for production of forage crops and possibly 100 or 200 acres for wheat where wheat has a place in the program. The rest is in grassland and former cropland returned to grass.

It is noteworthy that the Farm Security Administration's need for technical help to work out conservation programs for the reorganized farm units was met by the Soil Conservation Service, which has assigned technical personnel to cooperate in developing this phase of the work.

The Farm Security Administration will lend the farmer money with which to buy a foundation herd of livestock and necessary equipment and to provide money for cash leases and operating expenses. The money is advanced as needed, and repayment schedules are set that will allow the farmer to take best advantage of the market prices. Annual home and farm budgets are made for each farm by the local farm security supervisor. Diversification is encouraged with the development of as many productive enterprises on the farm as can be efficiently conducted. Taken into consideration are the contributions and requirements of the entire family. At least 1 year's feed supply is held in reserve. Trench silos, inexpensive to construct, are used.

The plan calls for the farmer to develop water-spreading devices and arrange for stock water. Range surveys are made annually so that the grazing land will not be overstocked. And it is to be noted that farmers may carry out these soil and moisture conservation practices in cooperation with the Agricultural Adjustment Administration program, particularly on the portion of the operating unit that is being restored to grass.

During the last year and a half, 133 farmers have come into this program, the average loan being $1,740. The average change in acreage for these farms has been from around 600 acres in the old unit to 2,500 acres in the new unit. To date, some 300,000 acres have been brought into better use through this program. Three hundred other plans of this type are being worked out at the present time, to be completed in the near future.

Supplementing the unit-reorganization program, the Department of Agriculture has directed its efforts in several other ways toward solution of the problems of the Southern Great Plains.

For one thing the restoration of land in grass, in those areas where most of the grassland has been destroyed, is too costly for the private owner, and requires a considerable period of time before the land has much economic value for grazing. Probably the best use of the submarginal land purchase program under title III of the Bankhead-Jones Act is for the Soil Conservation Service to make its purchases with the reorganization of particular units in mind. The Service can begin restoration to native grass, and as soon as the land is usable, lease it to the farmer for a long time, with the provision that the land be used for grazing purposes only. Such projects already have been established.

For another thing, many landowners would like to restore their land to grass, but they are discouraged by local tax situations. Not only are these tax rates assessed on valuations made during the boom years, but also there is a very small differential between tax rates on cropland and land earmarked for return to pasture. The States could make a considerable contribution toward a stabilized agriculture for the region if they found it possible to tackle this problem.

Already considerable progress has been made toward tax adjustment in one State—Colorado. Last year the Bureau of Agricultural Economics and several county planning committees looked into the tax situation in a number of counties in the southeastern part of the State. Representatives of the Bureau discussed the matter with the Governor of Colorado. As a result, he called the State tax commission to discuss the matter further; the commission made recommendations to the counties for lines of action in tax adjustments; and results were forthcoming.

It is hoped that as time goes on, the aid advanced by the Department of Agriculture toward the solution of the problems of the Plains farmers will be greatly increased. But while the Department can do a great deal, the final responsibility lies with the farmers themselves.

From now on, as Dr. Bushrod W. Allin has explained in an earlier issue of Soil Conservation, the farmer is going to be able to take a more active part in program making, and to have the benefit of a greater volume of technical help in so doing than he has in the past. The machinery for farmer planning is being set up in every agricultural county in the United States and farmer-drawn recommendations already are beginning to arrive in Washington.

As county planning committees function more effectively, they can bring the practical experience of farmer members to bear on the necessary readjustments in the Southern Great Plains. In certain counties of the region, these committees have already taken the initiative in carrying out the unit-reorganization type of adjustment. For instance, in Elbert County, Colo., several unit reorganizations have been carried out where no Federal loans were necessary.

Again, the land-use classification map of Beaver County, Okla., and the county committee recommendations as to size and type of farm in each use-class area, are being used by the county supervisor of the Farm Security Administration. Farm management plans, which form the basis upon which the Administration loans are made, have been drawn up in accordance with the committee's recommendations.

These are hopeful signs. They show that Southern Great Plains farmers, out of their long years of experience on the land, have a definite contribution to make to the building of plans for the region.

If farmers can work for their own salvation, the Federal Government and the State governments will give the necessary assistance. In the long run, the reconstruction of Southern Great Plains agriculture is a job of cooperation.

Erosion-Control Lessons From Old-World Experience

II. FISH PONDS AND FIELDS IN ROTATION

By W. C. LOWDERMILK [1]

Bringing in the crop of fish in net baskets, to be placed in tanks of fish merchant or in small holding pond. The basketful weighs about 70 pounds.

FISH culture in ponds is becoming more and more important in the United States. Thousands of ponds throughout the Nation are devoted to a comparatively new farm enterprise in this country. The experience of older countries for centuries in fish culture will be of special interest and value to American agriculture. The rotation of fish culture with field crops constitutes a unique method of land use to be found in many parts of France. The method reaches its highest and most intensive development in the region of Les Dombes, Province of Ain, lying between the Saone and Rhone Rivers above their junction and north of Lyon. In this region ponds are strung like beads on the drainage channels of shallow valleys.

Topographically the region in question is a broad flat dome sloping from Villars, a town near the center, toward the Saone and Rhone Rivers in gentle gradients of 1 to 2 percent. The area of approximately 250,000 acres is drained by broad shallow valleys marked originally by occasional marshes; thus the land lends itself to the impounding of waters by comparatively low cross dikes or dams. It is said that prior to the fourteenth century the area was covered with forests, and that the original clearing was for agricultural crops. The natural fertility of the soil is low so that the area is not highly productive of the usual agricultural crops of this region.

The soil, as well as the topography, is especially suited to the impounding of water in shallow ponds of considerable areas. The origin of soil material is disputed, although it is associated with the terminus of the great ice sheet of the Wormian Glaciation which moved down the Rhone Valley as far as Lyon. The soil is a heavy clay of low permeability.

The climate also favors this strange adaptation in the use of agricultural lands by supplying an annual average rainfall of about 30 inches, varying in rare extremes from minima of 18 inches to maxima of 40 inches. Precipitation is favorably distributed throughout the year—it averages 1.36 inches in January to 3.6 inches in September—to supply necessary quantities of water to keep down evaporation as well as to replenish losses. An average annual relative humidity of 72 percent also prevents excessive evaporation loss of water from pond surfaces.

The development of fish culture in this region dates back to the Middle Ages; it was well established at the time of the first written record of it in 1570. The origin of this interesting combined use of land and water is said to have been due to serious depopulation of this part of France by wars of the fourteenth century, which at the same time brought on a serious shortage of agricultural labor. Landlords, following examples set by abbeys, introduced the culture of fish in natural ponds; and later when it was found to be productive and profitable they extended the method to artificial ponds impounded by comparatively low dikes across shallow valleys.

Thereafter this method of combined land and water use developed extensively until in the eighteenth century, when the population began to suffer from numerous maladies, including malaria. The death rate ran high, to alarming numbers. The ponds of Les Dombes region were considered the origin of these maladies, whereupon laws were passed to restrict numbers and use of fish ponds. Under a number of laws beginning with that of July 21, 1856, the area in ponds was reduced from 48,000 to 21,600 acres by the end of the century. When it was discovered that the sickliness of the population was due more to malnutrition than to malaria, and with improved conditions of public health, the restrictions on fish culture were relaxed. Since 1904 fish culture has increased until in 1938 approximately 30,000 acres are devoted to this purpose. The industry is now thriving and proving more profitable than the production of field crops.

[1] Assistant chief in charge of research, Soil Conservation Service, Washington, D. C.

Les Dombes area, Province of L'Ain, France.

Two types of land use prevail in Les Dombes, corresponding to the adaptabilities of the land. Higher land above pond levels is devoted chiefly to permanent pasture for the production of livestock, while the floors of the broad shallow valleys are dedicated to the rotation of fish culture and field grain crops.

The pastures, at the same time, yield run-off from the rainfall to fill and replenish the ponds. Experience dictates that the catchment area must be not less than six times the pond area which it supplies. Moreover, it is necessary to conserve the run-off from the catchment areas. When a pond higher up the drainage is emptied, the water is caught in a field lower down to form a fish pond. The farmers make use of the same water as it is passed progressively down the drainage, from field to field, until finally it is discharged into a main drainage.

An assured water supply is essential to this rotation of pond-field culture and it has a value, even as has the land. Though not stipulated in deeds, the rotation of pond and field down a valley is definitely set by rigid custom. Failure to respect successive right to the use of pond waters occasionally leads to sharp litigation. In general, however, farmers can depend upon the water being turned into their fields in accordance with the unwritten but time-honored custom.

Of the total area of 250,000 acres in Les Dombes region, 40,000 acres are devoted to fish and crop rotation; between 25,000 and 30,000 acres are constantly in water surface. The remainder of the area is in permanent pasture, occasional grain crops, orchards, and hay.

Land features influence the size of ponds, which varies from 30 to 600 acres; the usual size falls between 50 and 100 acres. The average depth of fish ponds is between 7 and 10 feet with a maximum of 15 feet. In isolated ponds, the treatment in a rotation is not so definitely fixed as it is for ponds in series set in a drainage.

Dikes, or earthen dams, across valleys are well constructed, with thoroughly tamped cores, and are fitted with gates and spillways. Overflow from a pond is by-passed in special canals down the valley where it may be diverted through intake gates into one or more ponds deficient in water. The dikes also serve as elevated roadways across the valley. Ponds bordered by streams are well situated for water supply to supplement the discharge from emptied ponds up the valley.

The usual rotations for Les Dombes region are 2 years in water and 1 year in grain, and 2½ years in water and ½ year in grain. In other parts of France this rotation may be varied more readily than in Les Dombes where rights to successive use of water by farmers lower down the drainage fix the rotation more rigidly than in a less intensely developed region.

A number of species of fish are grown in these ponds, of which the following are most important: Carp (*Cyprinus carpio*); tench (*Tinca tinca*); pike (*Esox lucius*); and whitefish (*Coregonus clupeiformis*).

Sometimes other species such as eels and catfish, get into the ponds by accident. Eels are welcomed, but so destructive are catfish that every effort is made to eliminate them from the ponds. Carp make up about 50 to 60 percent of the stocking. In recent years a new strain of carp without scales has been introduced and it is found to be more productive than the carp with scales; it increases in weight 2 to 2½ times that of the usual or scaly variety.

Nursery ponds are stocked with mother fish, which are specially guarded and protected. The ratio of male to female is 5 to 2 in the nursery ponds. Each

mother carp will deposit about 200,000 eggs which hatch in May.

Young fish for stocking ponds are raised in special and small nursery ponds which may or may not be permanent. The fish are given special names to designate their age and size, as follows:

Fish at 6 months are called "feuille," weight about 10 grams.

Fish at 18 months are called "panot," weight about 100 grams.

Fish at 30 months are called "poisson," weight about 2,000 grams. The 2½-year-old carp, weighing 2,000 grams or 4.5 pounds, is ready for the harvest and the market.

Ponds are stocked at the rate of 1,600 feuille per hectare, 600 of which are allowed for losses. The carrying capacity or stocking of a hectare is placed at about 1,000 net. A year later the ponds may be seined to collect the "panot" or 18-months-old fish for redistribution so that each hectare of pond shall be stocked with the so-called "100" of panot which in reality is 160, allowing 60 for possible losses during the coming year. Extra panot above those needed for the pond are transported for stocking in other ponds. In a year the panot gain 20 times their weight at 18 months, i. e., from 100 grams to 2,000 grams. One hundred full-sized fish at an age of 2½ years are often harvested from a hectare of water surface. This is 200 kilograms or 440 pounds of fish—176 pounds per acre.

Records on a pond of 450 acres, from 1850 to 1880, showed an average production of 146 pounds per acre. Since then production has averaged 164 pounds per acre. This weight was made up of:

	Percent
Carp	55
Tench	25
Pike	3
Whitefish	17
Total	100

It is interesting to compare the production of beef on permanent pasture in this region; it has averaged 149 pounds per acre per year. The poundage of meat production favors fish culture, as do also the outlay for labor and the net income.

The fish find their food in the abundant faunal life of the ponds. For some time it was thought that the fish fed upon the vegetation submerged in the ponds. Life history studies by Professor Leger of Grenoble have proved that this assumption is incorrect and that actually the fish are carnivorous; they live on plankton, and on the insect and crustaceous life which thrives on vegetable matter and living plants in the water. The carp is a rooter; drained ponds disclose rough ground where carp have rooted in the bottom of the lake for food, as a hog in the forest floor for acorns.

Experience shows that it is inadvisable to feed fish; sufficient food is to be had in the shallow ponds, and the exercise in search of it ensures a firmer and better quality of flesh on the fish.

Occasionally it is desirable to apply basic slag to a pond to add phosphorous, but more especially to neutralize the water, since these species of fish flourish best in neutral or slightly alkaline water. For this reason it is best not to have forests within the drainage area—sour or acidified waters would flow from forest land into the ponds—and accordingly, drainage areas or catchment basins are usually left in pasture. Likewise it has been found that it is inadvisable to allow the pond vegetation to grow out of the water, and the plants are therefore mowed at the surface of the water. A mowing machine attachment on boats is used for this purpose.

The fish are harvested in the spring and in the autumn—most often in March so that a crop of summer grain may be sown in the pond area. When a farmer decides to harvest his fish crop in a pond he arranges with a fish merchant and his neighbors for a date suitable to all. At the hour set, in accordance with the time-honored right of succession, the gate in the dike is opened and the water is allowed to escape from the pond into a field lower down the drainage. When the water surface is reduced to a comparatively small area the gate is shut, and the harvest proceeds by seining the reduced pond. The fish are collected and placed in a trough full of water, from which various species and categories of sizes are divided, placed into baskets of netting and carried, some to the fish merchant's tank on his wagon or truck, and others into small holding ponds from which they will be transferred later to other ponds for stocking.

Usually it requires about 10 men working 6 hours to harvest the fish from a large pond of 60 to 90 acres. In less than 1 day's work it is possible to harvest a crop which has grown for 1 or 2 years on this watery field. The yield from the water crop of the rotation is greater than the yield from the grain crop of the rotation. The rotation to field crops is desirable to provide conditions for fish food and in turn the fish fertilize the grain crop.

After a spring harvest of fish and when the area is sufficiently dried out, the land is plowed into narrow strips, three times around, and sown, usually to a

A pond being drained, disclosing the lands of former cultivation. The valley is shallow, suitable to impounding waters with low dams or dikes.

crop of oats. The oats are harvested in July or August and then the field may be flooded in the fall and again put to fish culture for a period of 2 or 2½ years. When the harvest takes place in the fall the land is plowed or left fallow throughout the winter and then plowed in the spring for a grain crop, usually oats or spring wheat. At times the shallow portion of the pond may be sown to a mixture of clover and grass for production of hay. In some instances the field-crop phase of the rotation may be extended to 1½ years, but the most common practice in Les Dombes is 2½ years of water and ½ year of field crops in oats—2½ years wet culture and ½ year dry culture.

The rotation of fish pond to field culture in Les Dombes represents the highest type of land use for the area under present conditions. The soil of Les Dombes is normally poor for agricultural crops, but when flooded for production of fish, in the manner described, it forms the basis for profitable land use. Furthermore, fish culture requires less labor than ordinary agricultural crops; it is especially advantageous during these times of scarcity of agricultural labor in France. It is possible for a farmer and his son or one helper to manage farms of considerable size. We visited one farm of nearly 300 acres which is managed by a man and his son without hired labor, except for the 1 day of fish harvest when he calls in his neighbors. But he in turn helps his neighbors when they require it and the farmers are thus able to carry on their fish culture without additional hired labor. This type of land use is on the increase rather than on the decrease—it is now being extended to other portions of the country where conditions are favorable for storing water in ponds for the production of fish.

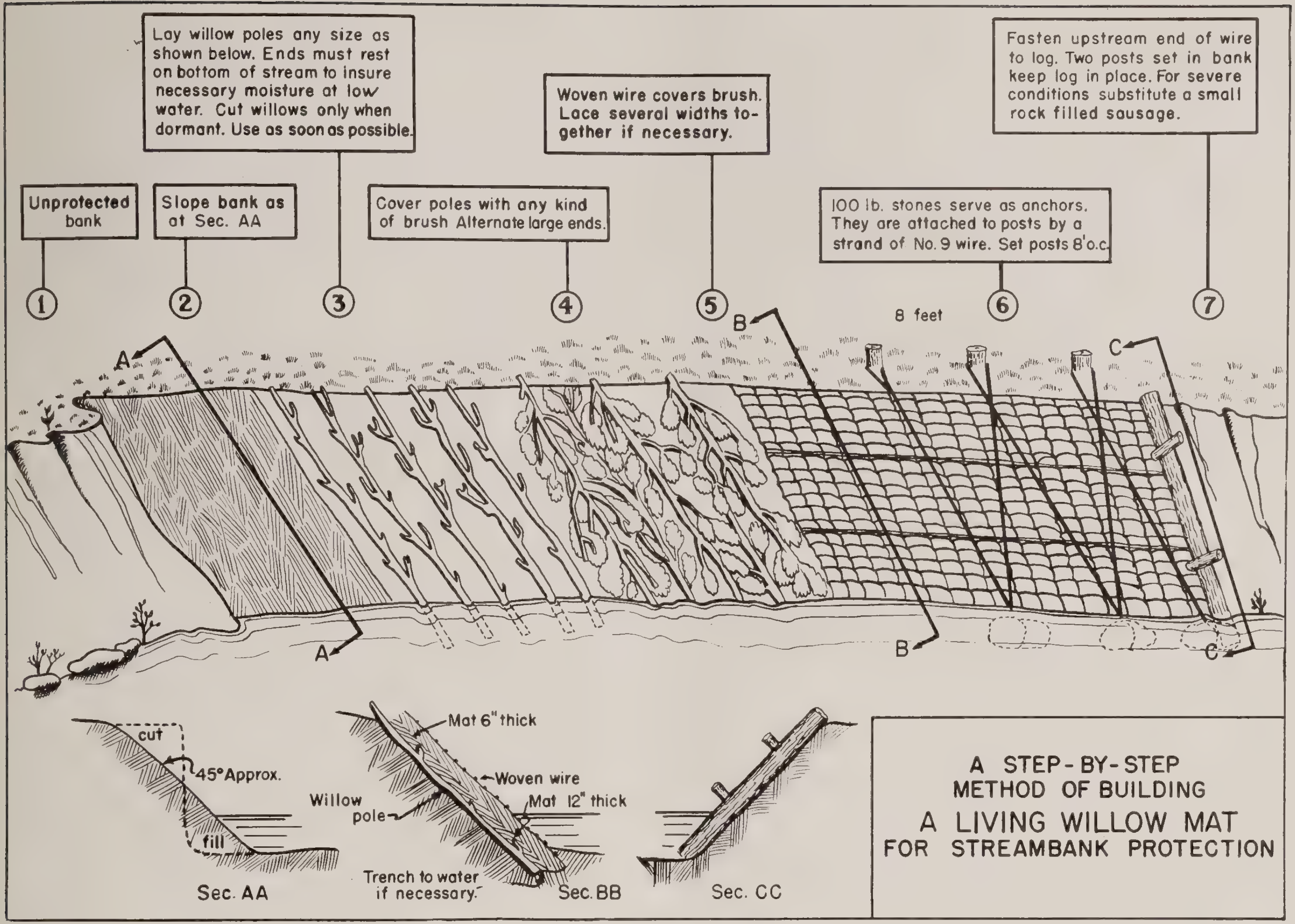
WATER FACILITIES PROVIDED

Fifty-four water facilities areas of the Department of Agriculture, in 17 of the Western States, have been established in cooperation with local and State planning agencies. Farmers and ranchers of these arid and semiarid States receive help in financing and developing their small water supplies—stock ponds, irrigation wells, pumps, and springs—for livestock, crop, and domestic use. Groups of farmers construct water facilities that are too large for individual undertaking.

The farmer or rancher agrees to carry out a soil and water conservation program planned by technicians of the Soil Conservation Service. After that, he may be the recipient of Federal aid. The Service is responsible for the operations phase of the water facilities program. To reduce water deficiency and cost of operations, the Service furnishes technical assistants to relocate lateral ditches, to find locations for concrete drops to prevent water channels from washing out, and to space the field laterals close enough together to prevent over-irrigation on the upper parts of the field.

The water facilities program has progressed rapidly. Requests from more than a thousand applicants have been received for establishment of additional areas. Approximately 800 farm families of the West are now receiving benefits from the program.

The county agricultural agents, or the nearest officials of the Soil Conservation Service and the Farm Security Administration, have available information on how to obtain help in developing water supplies in the Western States.



WILLOW MATS HALT STREAMBANK EROSION

By L. B. MOREHEAD [1]

THE Ohio Valley region of the Soil Conservation Service has developed a method of streambank protection by the use of living willow mats. The method has proved simple, inexpensive, and highly effective. Briefly, the steps involved in construction are as follows:

1. Mats are laid during the time of year when willows are dormant.

2. The eroding bank is graded to about a 45-degree slope.

3. The willow (white, *salix alba*, if possible) poles, of any diameter, are laid about 2 feet apart up and down the slope. The butt ends of the posts are pushed well down into the water so that they will remain in water even during dry weather. Poles extend from the water to the top of the slope. All limbs are removed and poles are placed the day they are cut, to prevent drying.

4. The poles are covered with brush, the bushy tops of which are alternately placed at the top and bottom of the bank. Brush may be of any tree species, but willow lays better. This layer of brush should be built into a mat about 12 inches thick at the bottom (where it goes below the water line) and 6 inches thick at the top.

5. Old woven wire is laid over the mat in horizontal bands and laced together with smooth wire.

6. Stub posts are set about 8 feet apart along the top of the mat. Weights of large rocks, concrete, or other heavy material are placed on the mat at low-water mark and attached to the posts by long No. 9 wires. These wires, extending from the posts at the top of the bank down over the mat to the weights, hold the weights in place and keep the mat in place during heavy floods.

7. At each end of the mat a wire should be fastened to a small log and the log secured to a bank by means of

(*Continued on p. 131*)

[1] Area technician, Soil Conservation Service, Mount Vernon, Ohio.

A PRELIMINARY STUDY OF VARIABILITY OF RUN-OFF PLOTS

By B. H. HENDRICKSON [1]

A NUMBER of run-off plot uniformity tests have been made at several soil and water conservation experiment stations during the last few years, with widely varying results as to uniformity of run-off. Despite all efforts to construct two or more plots as exactly alike as possible, side-by-side, on apparently uniform soil, only a single instance is known to the writer of exact duplication in run-off data obtained.[2]

In constructing a series of new run-off plots at the Southern Piedmont Experiment Station, triplication and randomization will be used in order to increase precision and to provide a valid estimate of error. This article reports very recently acquired preliminary run-off data obtained from some of these plots, with an interpretive discussion.

On the Southern Piedmont Experiment Station near Athens, Ga., with 18 new run-off plots equipped with sheet steel troughs and multislot divisor boxes and tanks, a short uniformity test of run-off variability has been completed. The plots were all located on Cecil sandy clay loam soil, of 7-percent slope. No attempt was made to mix soils or otherwise artificially produce uniformity of plot soils for this extremely variable soil which, to plow depth, is a mechanical mixture of some of the original Cecil sandy loam topsoil with more or less of the plowed-up clay subsoil. This topsoil condition is notoriously "spotty" in field distribution, and extensive in occurrence. During plot construction, the minimum of cutting and filling was done to achieve smooth precise plot slopes of 7 percent. Three slope lengths are represented, of which sets of 6 plots each are 35 feet, 70 feet, and 105 feet long, respectively. All plots are 20¾ feet wide. During pretest, all plots were in oats.

During the pretest period from February 25 to March 30, 1939, eight rains occurred, each of which caused some run-off. Volume of rainfall totaled 7.81 inches for this period, ranging from 0.09 inch to 2.40 inches for individual rains. Rates of rainfall were all classified as "slow," not exceeding 1 inch per hour for a 5-minute period. Such rainfall conditions are likely to produce run-off data of extreme variability, that is, rainfall intensities not much greater than soil infiltration rates may be expected to produce run-off data tending to reflect these infiltration rates, and they are thus most useful in detecting inherent soil differences with respect to water intake. It does not follow that excessive-rate run-off, or run-off computed periodically or annually, will always be subject to interpretation in the same relative terms.

The accompanying table lists the cubic feet of run-off, per rain, from each of the 18 plots, with summarized data, for the pretest period.

[1] Project supervisor, Southern Piedmont Experiment Station, Soil Conservation Service, Athens, Ga.

[2] A single heavy rain produced 58.6 percent run-off from each of a pair of similar 1/15-acre plots at the Soil Conservation Experiment Station, Tyler, Tex., in 1933.

Pretest run-off (cubic feet per rain) obtained from 18 plots planted to oats, February 25 to March 30, 1939

Rainfall		Short plots						Medium-length plots						Long plots					
Date	Inches	1*	2	11	12	17*	18*	3*	4	13	14*	15	16*	5*	6	7*	8*	9	10
		Cu. ft.	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*
Feb. 25	1.22	5.0	7.6	7.3	5.7	3.0	7.3	26.6	24.9	11.1	4.2	5.7	4.0	12.8	2.6	2.2	2.2	3.8	7.2
Feb. 27–28	2.40	69.2	82.4	76.7	62.4	57.0	66.1	173.3	186.6	135.3	94.0	125.0	81.2	208.1	182.3	112.4	188.4	174.9	202.3
Mar. 1–2	.99	32.7	34.8	35.1	27.0	26.5	30.4	75.8	69.1	51.2	50.8	53.9	50.0	87.1	92.7	55.0	72.4	74.8	64.9
Mar. 6	.23	1.6	.6	1.8	1.9	0	.7	2.5	3.0	.9	1.8	1.7	1.0	2.7	2.1	0	0	2.9	4.9
Mar. 10	.65	18.4	15.5	20.9	13.1	11.0	12.5	30.8	30.3	29.4	24.2	25.0	23.0	46.7	46.0	28.7	37.1	47.1	47.1
Mar. 12	.09	1.6	.6	1.1	.4	0	.1	1.3	1.3	.8	.5	.6	.1	1.6	1.8	0	0	.2	1.3
Mar. 26–27	.67	1.7	.9	1.9	.8	.6	1.3	2.7	3.1	2.4	1.9	2.5	.9	4.0	3.1	.7	0	2.2	4.0
Mar. 29–30	1.53	40.6	39.6	39.4	28.1	29.4	35.4	77.3	69.7	64.2	54.5	64.4	56.1	111.7	106.3	73.1	69.2	87.4	103.3
Totals	7.81	170.8	182.0	184.2	139.4	127.5	153.8	390.3	388.0	295.3	231.9	278.8	216.3	474.7	436.9	272.1	369.3	393.3	435.0
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Percent run-off for period		36.3	38.7	39.1	29.6	27.1	32.6	41.5	41.3	31.3	24.6	29.6	23.0	33.7	31.0	19.3	26.1	27.8	30.8
Average percent run-off by slope-length groups		33.9 percent						31.9 percent						28.1 percent					

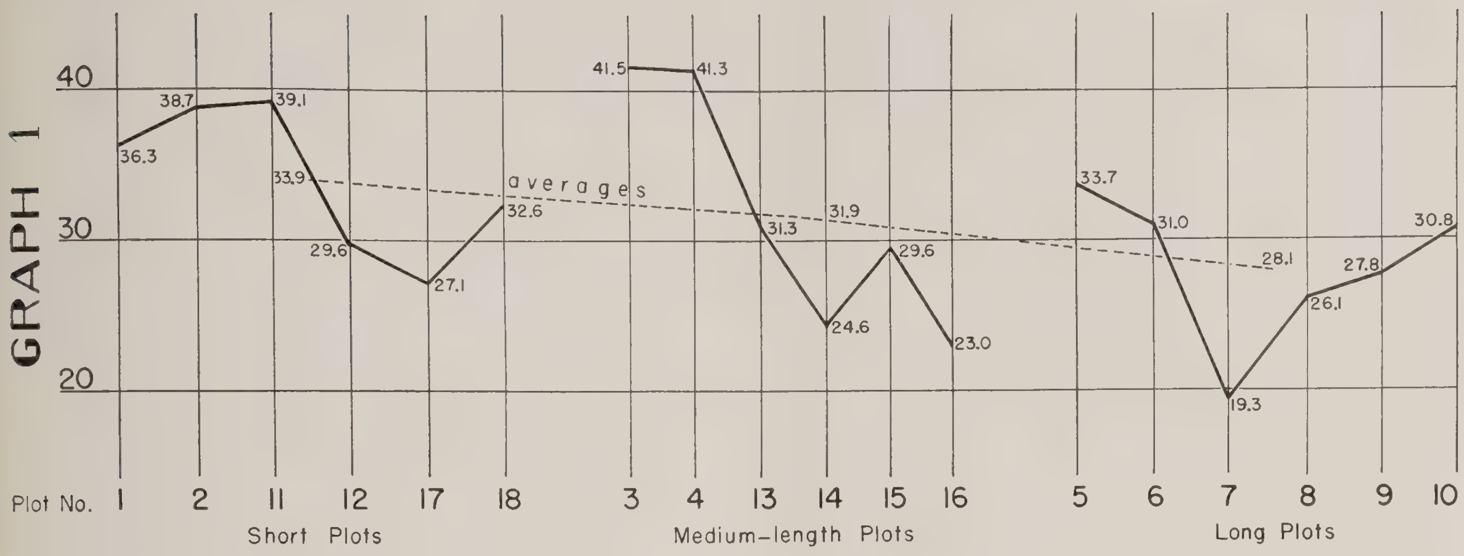
*Plots on which cotton will be planted in the subsequent rotation, with oats-cowpeas on the balance.

VARIABILITY OF RUN-OFF AVERAGES

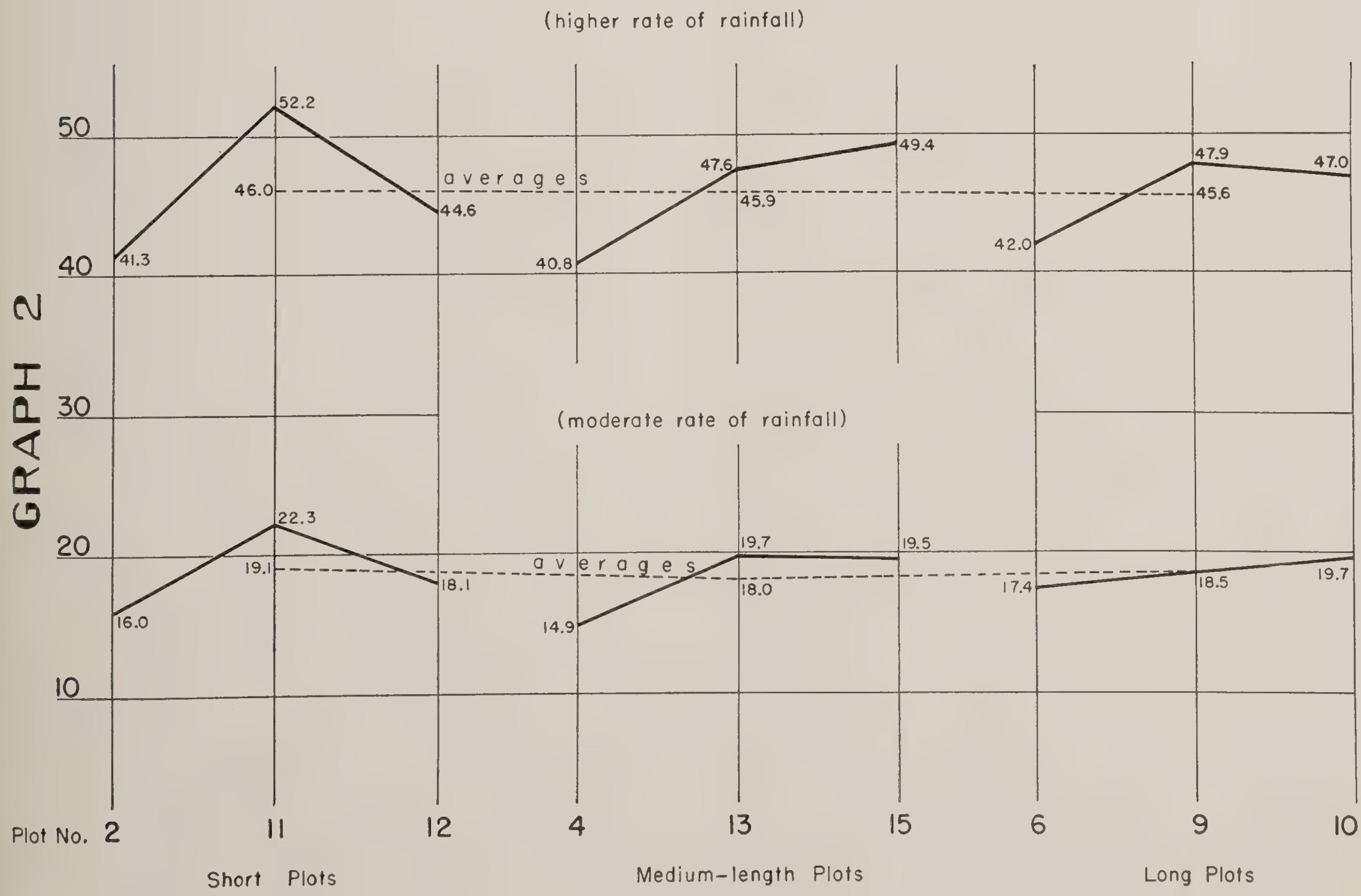
Plots selected for cotton, when in oats pretest period, averaged 32.0 percent (short); 29.7 percent (medium); 26.4 percent (long) run-off.
Plots selected for oats-cowpeas, when in oats pretest period, averaged 35.8 percent (short); 34.1 percent (medium); 29.9 percent (long) run-off.
Differences, when in oats pretest period, averaged 3.8 percent (short); 4.4 percent(medium); 3.5 percent (long) run-off.

Pretest run-off percentages obtained from 18 plots planted to oats

Period: February 25 to March 30, 1939



Run-off percentages obtained from 9 plots planted to oats during two small rains of moderate to high intensities



The plots selected for oats-cowpeas permitted a larger percent of run-off during the pretest period than those selected for cotton; this tendency is slight, however, as compared to the variation in run-off for the individual plots. For this period, the short plots averaged 33.9-percent run-off, the individual plot run-off ranging from 27.1 percent to 39.1 percent. The medium-length plots averaged 31.9-percent run-off, with individual plot run-off ranging from 23.0 percent to 41.5 percent. The average for the long plots was 28.1-percent run-off, with corresponding individual plot run-off ranging from 19.3 percent to 33.7 percent. These data are shown on graph I. A slight but gradual decline in average run-off percentages accompanies the increasing slope lengths.

Tendencies toward inherent plot variability in run-off are likely to be largely overcome when storm conditions are such as to produce high-intensity run-off, as from excessive rate rainfall or considerable volume. This type of data is of the most interest and importance, since peak run-off rates and associated high erosion losses from cultivated croplands are critical in connection with the design of diversion works as well as control measures in general.

Following the end of the pretest period, three small rains fell on these same plots. Half of the plots had just been bedded for cotton. It happened that the first rain was low in intensity; the second was of moderate rate—between 1 and 2 inches per hour for 5 minutes; and the third was of higher intensity—between 2 and 3 inches per hour for 5 minutes. All three rains totaled but 1.03 inches in volume. Only the oats plots produced run-off.

The run-off data for these nine oats plots for the two more intense of the three rains are shown on graph II.

This graph shows the substantial trend toward consistent relative run-off behavior of individual plots, under the stated conditions, and also shows indication of occasional erratic performance. A given plot may run relatively low in run-off for one rain, but high the next. This has not been true of all plots, nor of the bulk of a set of plots. The erratic run-off suggests variations in topsoil textures and depths as factors in relation to water intake.

It appears likely that with the use of randomized triplicate plots, valid run-off and erosion data will be acquired from these experiments. A 2-year rotation is planned, and the principal interpretations will be on the basis of either the losses associated with excessive storms, or the losses per rotation period.

In summarizing, most of the variation in run-off from these 18 plots has been due to rain characteristics. A slight tendency for the shortest plots to produce the highest percentage of run-off has been consistently noted. Variation between individual plots, or residual variation, is natural and desirable—in fact, unavoidable.

Since a representative spread of soil and erosion conditions such as are found in given fields within a single erosion survey classification, is included in this experiment, it should yield dependable run-off and erosion data.

A Sprinkler System

Clarence F. Olson, of Clayton, Oreg., installed on his farm a sprinkler system for irrigation. The system has provided him with more than a sufficient amount of water.

Mr. Olson financed his sprinkling system last June through the Farm Security Administration. He received technical assistance in working out his farm plan from the Soil Conservation Service.

With an electric motor and a simple pumping unit, water is lifted from the Yamhill River. Six hundred feet of main-line pipe pivots from a 200-foot stationary supply line. Outlets are provided every 60 feet, connecting the 780 feet of lateral line with its 13 hammer-head sprinklers. Each sprinkler throws a 90-foot circle of water. Mr. Olson varies his sprinkler according to the need of his crops and his grass.

Mr. Olson states that formerly 9 or 10 acres of grass were required for the support of 9 cows. Now, between 7 and 8 acres provide all the grass the cows can eat. He plans to increase his livestock, next year, to 12 milk cows and 7 yearlings, and this can be done easily as the grass on his pasture land is now well established.

Wildlife Population Increased

Protecting woodlands from livestock is a standard soil conservation practice, designed to produce better woodlands and conserve soil and moisture. But a recent survey made by biologists of the Soil Conservation Service revealed that woodland protection also greatly affects the wildlife population. These biologists, at Hamilton, Ohio, found that grazed woodlands had 111 pairs of birds per 100 acres. On the other hand, woods which were protected from grazing had 225 pairs of birds per 100 acres—more than twice as many as on the grazed areas.

CONSERVATION PRACTICES IN PRIMITIVE AGRICULTURE

(Continued from p. 115)

that had been observed in the locations examined in southern and central Arizona. The terraced areas in many instances were quite small, ranging from 5 to 12 feet up to plots of 8 to 18 feet. In this location again the present water supply is rather deficient for the terraced land. There is some evidence, however, that an early primitive reservoir may have been located about 3 miles distant on the plateau. It was my good fortune to examine this area, and the outlet ditch running down through the wood, in the company of Lancaster of the park staff, who has devoted considerable study to tracing this water system. In places there was a suggestion of old diversion water-detention dams, running off from the faintly outlined ditch which would have carried water along the plateau. At its lower end this ditch would have connected with the present Soda Canyon detention dams and, undoubtedly, would have furnished an adequate supply for corn or other garden crops. I was informed that the largest group of dams known upon the mesa was located some distance away on Wetherill Mesa, and this area would appear to warrant further examination at a later date. The Soda Canyon detention dams and agricultural area would have been readily available from the well-known ruin of Spruce Tree House, from which they are less than a mile distant.

To summarize the foregoing observations, it may be stated that water conservation was clearly the principal purpose of the early cultivators. Soil conservation in many cases was achieved incidentally, since the conservation methods used reduced the run-off and hence slowed down erosion. Throughout the area examined, extremely simple methods were employed. In very few instances was there any regularity or concerted arrangement of the terrace or plot layout. The tract above Pecks Wash near Pima, Ariz., was probably the most comprehensively laid out of any studied. On this area, however, it is doubtful that crops could now be grown, since the erosion control obtained on slopes of 3 to 5 percent was of a temporary nature and there is considerable evidence that slow sheet washing has occurred in the long period of time that has elapsed since use was made of this land by Indian cultivators. At other sites, as at Agua Fria, where the gradient was lower and there was more protective vegetation, examination of the soil profile indicated that crops could probably still be raised, and that the conservation practices had been effective in materially reducing erosion and excessive run-off.

As to present day Indian agriculture, the influence of these ancient practices may be clearly seen in the farming methods of Hopi villages. It is the writer's intention to discuss them in a future article.

WILLOW MATS HALT EROSION

(Continued from p. 127)

posts. Where the stream is large, it may be better to use a large rock-filled woven-wire covered "sausage" jetty, especially at the upstream end of the mat, so that extreme floods will not peel the mat back from banks.

8. Keep livestock out with fence or thorny brush, because livestock destroy willows.

The accompanying sketch depicts step by step the method of construction.

During the first growing season the willow poles send roots into the bank, producing a top growth of 2 to 5 feet. This dense growth develops into permanent protection to the bank, from below the water line to the top of the slope.

Ordinarily the cooperator can furnish all the materials, without any cash outlay except for smooth wire to hold the weights in place and to lace the old woven wire together. These mats are simple to build, and the work makes an excellent labor outlet during the slack winter season.

When the stream is a property line, this type of protection is especially desirable, as it does not change the course of the stream. Within one season after construction, the mat will have developed a dense growth which will hold the soil in place—prevent it from joining the stream in its journey to the sea.

WHEEL CHARTS FOR AGRONOMY

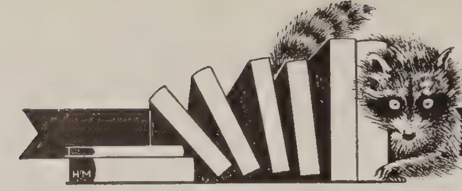
(Continued from p. 119)

degree of erosion studies by regional and area technicians are the bases for both."

The wheel chart must be prepared for each individual area—this because soil types, climatic conditions, and farming practices vary for different areas. The Fennimore chart would not apply to other areas where conditions are not the same. Should they wish to use the device, technicians in other projects will have to prepare charts suitable to their localities.

Similar in appearance to the wheel chart for land-use is a seeding chart devised by Pierre which gives at a glance the rate to seed, the depth to plant, the yield per acre, the time to seed, the soil requirements, and the seed weight per bushel of 43 crops grown in the Fennimore project area. This chart could be easily duplicated in other areas, with a few substitutions for local conditions and crops grown.

From the original rough drafts of the agronomy and land-utilization wheel charts, tracings were made and photographed to secure brown-line duplications. Now, every Fennimore technician has one of the time-saving land-use wheel charts, and every agronomist carries with him in addition, on two sheets of paper, a veritable encyclopedia of seeding information.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

LAND DRAINAGE AND RECLAMATION. By Quincy Claude Ayres and Daniels Scoates. New York and London. October 1939.

The first edition of this book came out more than 10 years ago, before many of our special land and water policies and practices were put into effect. Users of the first edition will be very glad to know that the second edition, just off the press, is revised throughout to include a great volume of new material on soil and water conservation aspects of land clearing, drainage, and land reclamation. The information on control of erosion has been expanded from one chapter to three, most of this new material being taken from Mr. Ayres' Soil Erosion and Its Control which was reviewed in the August 1937 issue of Soil Conservation. As most users of such texts know, Mr. Ayres' treatment of terrace types, design and construction, constitutes today a standard work.

A considerable amount of very recent findings relating to terracing and control of gullies is taken from the works of Soil Conservation Service engineers. For example, a drawing, much used throughout the Service to show the drainage- or channel-type and the absorption- or ridge-type terrace is included in the chapter on terracing, as is also the recommended terrace-spacing table compiled by C. L. Hamilton and published in U. S. D. A. Farmers Bulletin 1789 under his name. Hamilton is quoted more extensively with regard to cost of terrace construction, combination strip crops and terraces, and design for drop-inlet structures.

Mr. Ayres is associate professor in charge of drainage and irrigation engineering at Iowa State College. The second author, Daniels Scoates, is professor of agricultural engineering, A. and M. College of Texas. Their new book is essentially an agricultural engineering text, but in its present form is designed as a workable guide for farmers and farm managers in working out problems on their land.

The introduction has been entirely rewritten to present the engineering features of land reclamation as related to, first, improvement projects, and, second, development projects. As classified by Mr. Ayres and Mr. Scoates, improvement projects are those designed for "reducing unit costs of production and making more productive lands which at present produce some income." Under improvement projects come the following: Farm drainage; control of soil erosion; watering land formerly dry farmed; brush, stump, and stone removal; channel improvement and levee building; drainage of irrigated lands. Development projects, for "bringing into production lands which at present produce no income," include those involving swamp drainage; irrigation; land clearing on large-scale operations; levee and pumping plant construction; reforestation; flood control. An excellent brief history of land drainage is presented in the first chapter, to introduce the discussion of advantages and disadvantages of irrigation and soil-erosion, flood-control, and cut-over land problems today confronting the people of the United States.

The technical text proper begins with chapter 2. About a hundred pages are given over to surveying and mapping, with emphasis on those principles essential to farmers and landowners in laying out land and running boundaries.

Chapters 11 and 12 are devoted to the physical elements (soil and rainfall) having to do with drainage and land reclamation problems, and here is found a careful explanation of the object of the two kinds of drainage—surface and subsurface. Following this is a thorough treatment of open-ditch design, location, construction and maintenance, and of earth dam and levee construction. Much of this part of the text is definitely for the drainage engineer, although the chapter on open-ditch maintenance should be exceedingly useful to the farmer with a surface drainage system on his land.

One looks for the subsurface drainage part of the book to follow immediately after the treatment of open-ditch design and construction; but instead the authors have chosen to include some 200 pages of other discussion and data before treating drainage for the purpose of lowering the water level below the surface of the ground. But once these 200 pages are given careful reading the chapter arrangement seems logical enough, for here is a great mass of up-to-date information relating to practices for the economic use of agricultural land. The purposes of drainage districts and soil conservation districts are first explained as to functions. Useful principles of the law, regarding farm water rights, are discussed for the benefit of the land owner and the agricultural engineer. Directions for the use of explosives in ditching and stump blasting on the farm are given in detail. The methods and practices for clearing cultivable land littered with brush, fallen logs, stumps and second-growth timber are described in detail, from surveying and planning to determine method and cost to the completely cleared field or large area under the plow.

Three chapters, Control of Soil Erosion, Terracing, and Control of Gullies, follow immediately after Land Clearing, and here is the material taken from Mr. Ayres' former book, Soil Erosion and Its Control, with which most agricultural engineers are familiar. Terrace types are defined, directions are given for their design, spacing, grades, length and cross sections, capacity, the surveying procedure and layout, construction; and then terracing equipment is described in detail, and cultivation and maintenance practices are emphasized, especially outlet maintenance.

Subsurface drainage is treated as a six-chapter section near the close of the book. Design of tile drains, selection of tile, installation of tile, and drain-tile accessories for protection of inlets and outlets, are the main subjects treated. Two chapters, Estimating Cost of Tile Drainage, and Special Methods of Drainage, close the volume with the exception of an appendix containing various charts, formulas, and tables for use by drainage engineers.

AMOUNT OF UNDERGROUND PLANT MATERIALS IN DIFFERENT GRASSLAND CLIMATES. By S. H. Shively and J. E. Weaver. University of Nebraska Conservation and Survey Division. Lincoln, Nebr. May 1939.

This new bulletin (No. 21, Nebraska Conservation Division) reports the results of recent studies carried out to determine the correlation between amounts of underground plant materials and aridity increase. Both true and mixed prairie plants were covered in the study; in the former, precipitation decreased by areas from 33 to 26 inches, and in the latter from 23 to 17 inches. Soil groups varied from Prairie to Chermozen and then to Dark Brown and Brown.

The grass samples were taken from nearly pure stands and from numerous mixtures, and included the bluestem, blue grama, buffalo, western wheatgrass, prairie dropseed, slough grass and gama grass. Some of the forbs that have increased enormously during drought periods, as many-flowered aster, daisy fleavane and smooth goldenrod, were studied to determine their relative amounts of underground materials and to compare them with the native grasses. Some 200 samples were collected over a region extending 600 miles in Iowa, Nebraska, Kansas and Colorado.

Exceedingly careful procedures were followed in preparing the samples for examination to determine volume and dry weight of root materials and to correlate these with precipitation and soils. The authors present their data in tabular form, according to the different grasses. Significant findings are pointed out in the text, and some especially fine photographic reproductions are used to illustrate experimental methods and various prairie stands.

During the process of the experiments, soil samples were taken for the determination of organic matter and nitrogen to a depth of 4 inches. The results are presented in table 8, and the authors point out as significant the fact that the average percentage of organic matter decreased from east to west over the region from 7.14 to 2.67. Percent of nitrogen decreased from 0.308 to 0.13. A brief general discussion of these data points out that "climate and soil have a profound effect upon the production of organic matter and total nitrogen in soils both in determining the amount of vegetation, and the extent, nature, and rate and completeness of the decay of the materials produced."

U. S. GOVERNMENT PRINTING OFFICE: 1939

1939 Bulletins Make Available New Information on Many Farm Subjects

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Survey of Greenbelt Lake, Greenbelt, Md., January 27–February 8, 1938. SCS-SS-33. April 1939. mm.[1]

An Analysis of Sediment Transportation in the Light of Fluid Turbulence. SCS-TP-25. July 1939. mm.[1]

Engineering Manual. Section 1: Job Planning and Estimating in Land Development. SCS-EP-16. August 1939. mm.[1]

Selected Annotated Bibliography on Sedimentation as Related to Soil Conservation and Flood Control. SCS-MP-20. June 1939. mm.[1]

Office of Information U. S. Department of Agriculture

Forest Resources of Southeastern Texas. Miscellaneous Publication No. 326. Forest Service. February 1939.

Growth of Lemon Fruits in Relation to Moisture Content of the Soil. Technical Bulletin 640. Bureau of Plant Industry and Bureau of Agricultural Engineering. May 1939. 15c.[2]

Land Use Adjustment in the Spring Creek Area, Campbell County, Wyoming. Soil Conservation Service. 1939. 10c.[2]

Prevention and Control of Gullies. Farmers' Bulletin No. 1813. Soil Conservation Service. September 1939.

Agricultural Experiment Stations

Agricultural Conservation Program in New Hampshire. Station Bulletin 314. New Hampshire Agricultural Experiment Station, Durham, N. H., in cooperation with Bureau of Agricultural Economics and Agricultural Adjustment Administration, U. S. Department of Agriculture. June 1939.

Bedford Experiment Field. Report of Progress, 1916–1938. Circular No. 243. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Differences in Iowa Farms and Their Significance in the Planning of Agricultural Programs. Research Bulletin 260. Agricultural Experiment Station, Ames, Iowa, in cooperation with Iowa State Planning Board and Works Progress Administration. June 1939.

Dry-Farming Investigations at the Mosquero, New Mexico, Experimental Field. Bulletin 265. Agricultural Experiment Station, State College, N. M. June 1939.

Economic Implications of Soil Conservation in Marshall County. Bulletin 293. Agricultural Experiment Station, Morgantown, W. Va., in cooperation with Bureau of Agricultural Economics and Soil Conservation Service, U. S. Department of Agriculture. August 1939.

An Economic Study of Land Utilization in Chautauqua County, New York. Station Bulletin 720. Cornell University Agricultural Experiment Station, Ithaca, N. Y. June 1939.

An Economic Study of Land Utilization In The Tobacco Area of Southern Maryland. Bulletin No. 424. Agricultural Experiment Station, College Park, Md., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. January 1939.

Evaluating Annual Changes in Soil Productivity. Bulletin 405. Agricultural Experiment Station, Columbia, Mo. June 1939.

Farming Conditions in Toombs County, Georgia. Bulletin 202. Georgia Experiment Station, Experiment, Ga., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. July 1939.

Farming Systems and Practices and Their Relationship to Soil Conservation and Farm Income in the Wheat Region of Washington. Bulletin No. 374. Agricultural Experiment Station, Pullman, Wash., in cooperation with Bureau of Agricultural Economics, Soil Conservation Service, and Agricultural Adjustment Administration, U. S. Department of Agriculture. July 1939.

Fifty Years of Achievement in Agricultural Investigation. Circular 60. Agricultural Experiment Station, Lincoln, Nebr. March 1939.

Herbert Davis Forestry Farm Soils and Crops Experiments. Report of Progress, 1923–1938. Circular No. 245. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Huntington Experiment Field. Circular No. 246. Report of Progress, 1919–1938. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Jennings County Experiment Field. Circular No. 244. Report of Progress, 1921–1938. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Phosphorus in Wyoming Pasture, Hay, and Other Feeds. Bulletin 233. Agricultural Experiment Station, Laramie, Wyo. June 1939.

Pinney-Purdue Experiment Fields. Report of Progress, 1920–1938. Circular No. 248. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Relative Water Requirement of Arizona Range Plants. Technical Bulletin No. 80. Agricultural Experiment Station, Tucson, Ariz. June 1939.

Sand Experiment Field. Report of Progress, 1924–1938. Circular 247. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Small Grain Varieties for Northern Arizona. Bulletin No. 166. Agricultural Experiment Station, Tucson, Ariz. May 1939.

Soils and Crops Experiment Farm. Report of Progress, 1915–1938. Circular No. 242. Purdue University Agricultural Experiment Station, Lafayette, Ind. May 1939.

Timber Farming in the Cloquet District. Bulletin 343. Agricultural Experiment Station, St. Paul, Minn., in cooperation with Lake States Forest Experiment Station, Forest Service, U. S. Department of Agriculture. July 1939.

Timothy Hay Compared with Alfalfa Hay as a Feed for Dairy Cows. Technical Bulletin 65. Virginia Agricultural Experiment Station, Blacksburg, Va. April 1939.

Types of Farming in Tennessee. Bulletin No. 169. Agricultural Experiment Station, Knoxville, Tenn. April 1939.

Types of Farming in West Virginia. Agricultural Experiment Station, Morgantown, W. Va., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. August 1939.

Miscellaneous

Creeping, Sprawling, Climbing Plants. Cornell Rural School Leaflet, Vol. XXXII, No. 4. Cornell University, Ithaca, N. Y. March 1939.

High Water Data: Floods of March 1936 and September 1938 in Massachusetts. Massachusetts Geodetic Survey, Boston, Mass. 1939. mm.

Legal Aspects of Flood Control. Senate Document No. 34, 76th Congress, 1st Session. (Letter of Acting Chairman of Federal Power Commission to Senator David I. Walsh transmitting Memoranda of Bureau of Law and of Bureau of Engineering of the Commission Relative to Various Aspects of Flood Control.) 5c.[2]

Report on Economic Conditions of the South. Prepared for the President by the National Emergency Council, Washington, D. C. July 1938.

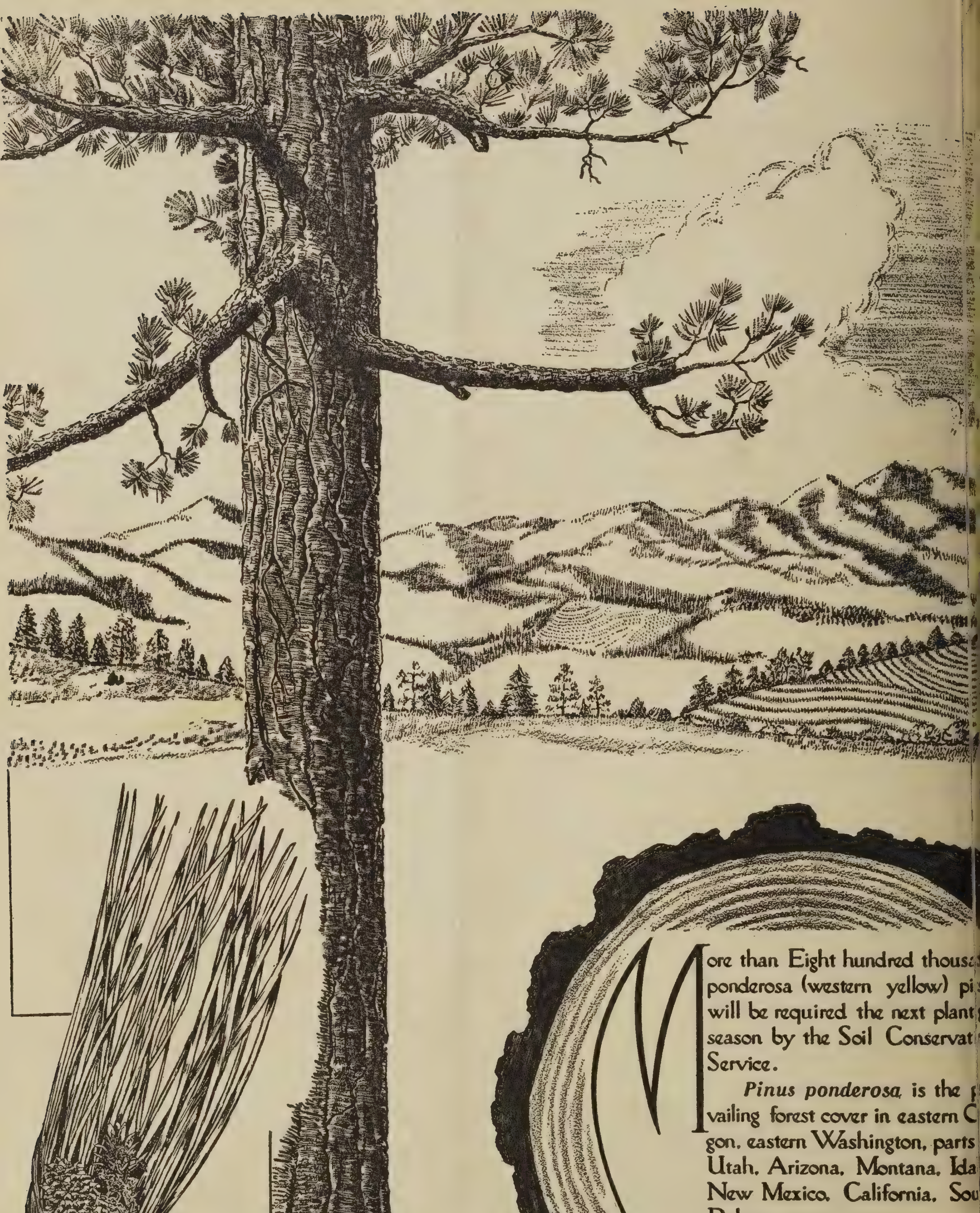
Storm-tide Hurricane of September 1938 in Massachusetts. Massachusetts Geodetic Survey, Boston, Mass. 1939. mm. (Supplement "High Water Data," listed above.)

Tenure Status and Land Use Patterns in the Corn Belt. Land Economics Reports, No. 5. Bureau of Agricultural Economics, U. S. Department of Agriculture. August 1939. mm.

---

[1] Issued for use by Soil Conservation Service staff and cooperating officials only.

[2] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.



More than Eight hundred thousa ponderosa (western yellow) pi will be required the next plant season by the Soil Conservat Service.

Pinus ponderosa is the p vailing forest cover in eastern C gon, eastern Washington, parts Utah, Arizona, Montana, Ida New Mexico, California, Sou Dakota.

The tree does best on go soil but readily adapts itself difficult sites. It is hardy, a is well suited to forest plantin

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

Vol. V · No. 6

JACK MANWEILER'S SURVEY WAS no job for a tenderfoot. He risked his life on difficult northern trails. He braved the punishment of cold in winter and insects in summer. But he brought back to Minnesota the nucleus of a new herd of woodland caribou. Beginning on page 138, William T. Cox tells the dramatic story of Manweiler's achievement.

IT IS AXIOMATIC IN THE WEST that snow is water and water is wealth. Farmers, cities, power companies, know that their destinies are closely related to the accumulations of snow in the Rockies, the Cascades, and the Sierras. Aspects of the snow-survey and water-supply forecasting service are discussed in two articles in this issue—pages 144 and 148.

DECEMBER

1939

Contents

Front cover by Adrian Clem

Back cover by C. E. Margraff

WELLINGTON BRINK
EDITOR

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. Soil Conservation seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

FROM A RECENT ADDRESS BY THE SECRETARY OF AGRICULTURE

"Now what are the American goals worth working for? What are the things we must do to make this, our own land, the Chosen Land?

"We want to see abundance widely shared. What must we do to assure abundance for ourselves and our children and our children's children?

"Our first concern must be the land itself. Our agricultural fertility, our forests, our watersheds, our entire national life are bound up with the welfare of our soil. When the productive soil is ruined, our civilization will be ruined, and our country will revert to desert and wasteland, like the ruined lands of Africa and Asia.

"For many years, we did not realize our danger. Then, with dramatic swiftness, nature brought the lesson home. Five years ago last spring, when millions of tons of powdery soil were lifted by the wind from the thirsty plains and carried across the country and far out over the ocean, nature wrote her warning in the sky. She spread that warning even on the walls in thousands of metropolitan homes.

"Not only with dust, but with water, has nature broadcast her ominous message. Floods in New England, floods in Pennsylvania, floods along the Ohio River, floods here in California—year after year we have been forcibly reminded of the crimes we have been committing against the soil."

—HENRY A. WALLACE.

Results of selective clearing. The large stump yielded fence posts. Three cuts of oak in the middle background; cordwood at middle left. In the picture above, the clearing is rapidly seeding in. The "after" sequence is seen in the picture below, which shows woods improvement well under way. Farm forestry as a part of the better land use program is discussed in Dr. Bennett's article beginning on the opposite page.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 6 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON DEC. • 1939

COOPERATIVE FARM FORESTRY—ANOTHER AVENUE TO BETTER LAND USE

By H. H. BENNETT [1]

THE only certainty about the work being done today to encourage better land use and conserve soil resources is that no single, simple panacea exists which will do the job. Every field and every block of land, on every farm and ranch, will have to be treated according to its individual needs and used according to its individual capabilities if true, Nation-wide conservation is to be achieved.

Farm forestry is one of the several types of work in which the Soil Conservation Service is interested. Since the recent congressional appropriation under the Norris-Doxey Act for such work, however, there has been considerable speculation about the place of farm forestry in the total Service program. This has resulted, perhaps, from an inclination to magnify out of true proportion the importance of this phase of our program. I trust this statement will not be interpreted as a minimization of farm forestry; that is not my intent. Work on the farm woodlands of the country is extremely important, but it is nevertheless only one part of the work that needs to be done.

To arrive at an accurate perspective of the Service's participation in the new, cooperative farm forestry program, it is essential first of all to remember the larger job the Service is trying to accomplish. Despite all the organizational developments of the past few years, the fundamental task of this agency is to encourage better use of land. Of course, recent laws of Congress, administrative orders, and the development of soil conservation districts have expanded the scope of our activity in several important directions. In some ways, the Service today is a far different organization from the agency that started helping farmers to control erosion back in the fall of 1933. The chief difference is that land-use adjustments are now being made over a broader area than ever before.

Throughout the country, the need for better husbandry of available resources is nowhere more acute or more widespread than on the 185 million acres of farm land that carry a forest cover. Comprising roughly 18 percent of our total agricultural area, woodlands are almost traditionally neglected by the farmer. Out of 138 million acres of farm woods with possible commercial value in the United States, only 30 percent, according to a Forest Service survey, is receiving anything like intelligent management. Only 1 percent is getting really first-class intensive treatment. Moreover, in far too many cases, farm forests are being definitely abused. Grazing, deliberate burning of undergrowth, and indiscriminate cutting year after year are steadily lowering the timber growth on thousands of farms—destroying its potential value for income production. Unless this tendency is checked and even reversed, we can never hope for a completely satisfactory solution of the Nation's land-use problem.

Trees have played an indispensable part in our erosion control program from the very beginning of such work. They have helped to tie down steep eroding hillsides that were no longer able to produce crops after years of continuous cultivation. They have furnished a sheltering cover for worn-out pastures that were practically devoid of forage and streaked with rainfall gashes. They have served to choke the growth of large gullies, to stabilize unsteady streambanks, and to screen off cultivated fields from soil-robbing winds. Altogether more than 440 million

[1] Chief, Soil Conservation Service, Washington, D. C.

trees and shrubs have been planted in camp and project areas. This much has been done by the Soil Conservation Service alone. Other agencies of course, both State and Federal, have done more work along this line and over a longer period.

In the expanded program of the Service now going forward, trees will continue to be a most valuable tool of land-use adjustment—a potent weapon of defense against erosion, floods, and silting—and a means of increasing the productivity of certain farm lands. Over the farm lands of the Nation, there are millions of acres now in cultivation, in pasture, or idle that should have a tree cover both for their own protection and for the benefit of lands, structures, and people farther downstream. Where these lands are a part of related farms or groups of farms, the best practical solution may be purchase and development by some agency of government. But in a majority of cases, submarginal crop and pasture lands can be converted to woods without disturbing the existing pattern of ownership. Usually it can be done with profit if woodlands are established not merely as a stop-gap but as a positive, income-producing part of the whole farm economy.

It is precisely at this point that farm forestry work has its most direct bearing on the basic land-use problem the Soil Conservation Service is helping to solve. The ultimate aim of the new program is to show that forestry on the farm is a paying proposition—to illustrate to farmers that time, money, and effort spent in the farm woods will yield a satisfactory return. Once trees are widely recognized as a crop and treated with proper care, reforestation of unproductive fields and pastures will become a desirable move from every point of view rather than—as it now so often appears—an unwarranted economic sacrifice on the part of the farmer. As land-use adjustment is made easier, its progress over the country will inevitably be accelerated.

In carrying forward the new program, a number of State and Federal agencies will work together to assist the farmer. The State extension services will bring forestry information to the farmer, and help to make the forestry projects effective. State forestry agencies will assist farmers in woodland management and in the production and distribution of planting stock for the projects. The Bureau of Agricultural Economics will take part in the development of State farm forestry programs which eventually will comprise a Nation-wide farm forestry plan. The Forest Service will cooperate in scientific investigations and have departmental responsibility for all projects established in areas where most of the farm income is derived from forest products. The Soil Conservation Service will have similar responsibility for those projects located in areas where timber production is not the dominant factor in the prevailing farm economy.

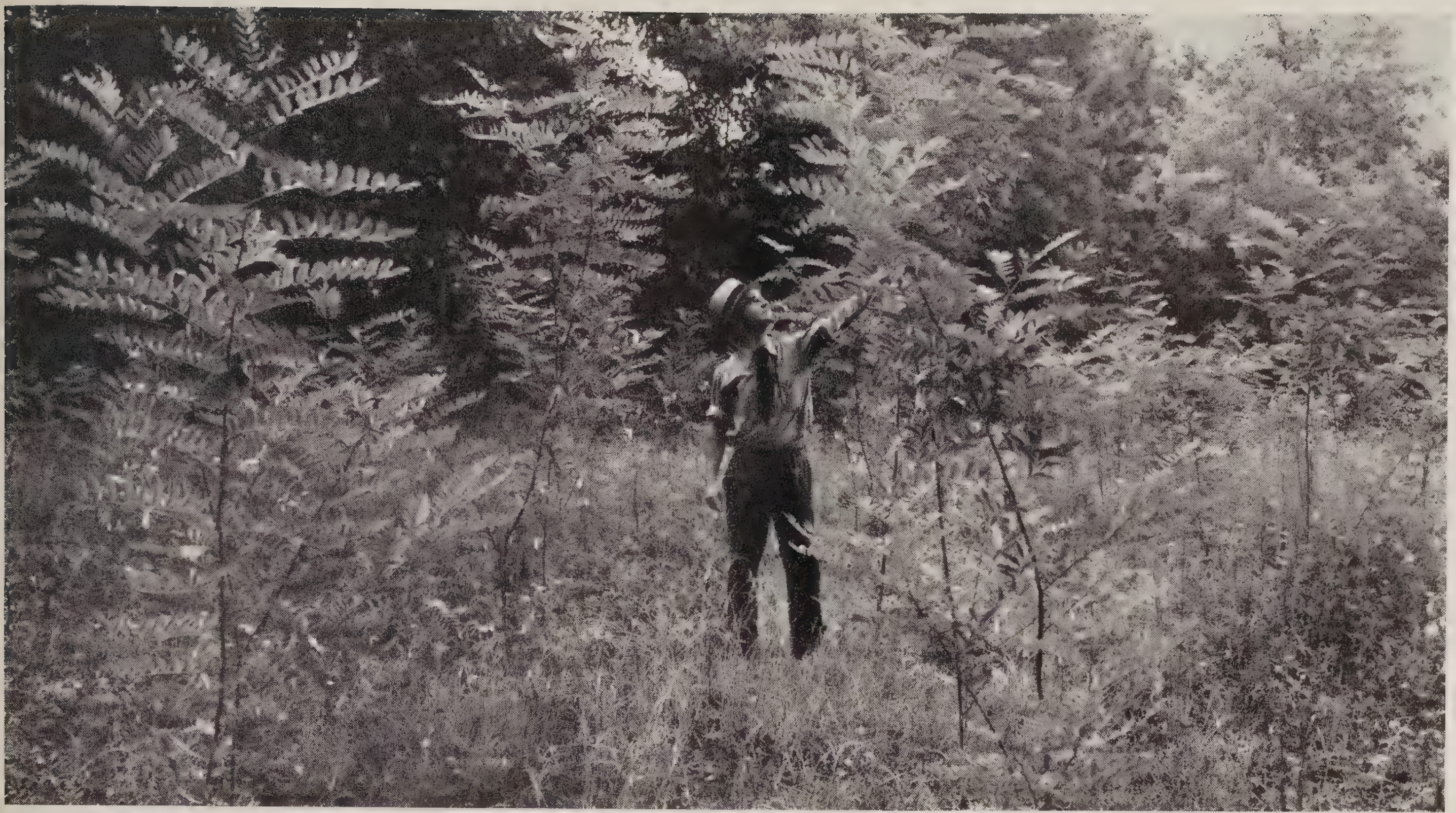
Projects of this latter type will be called "farm forestry" demonstrations as distinguished from the "forest farming" projects of the Forest Service. Like the forest farming projects, however, they will be selected by a State committee, composed of representatives from each agency taking part in the program, which will be a subcommittee of the State Agricultural Advisory Council.

Once a farm forestry project has been set up, it may differ from the usual erosion control demonstration mainly in that major emphasis will be placed on sound woodland management. In each of these new areas, farm forestry work will have priority over other types of activity, but at the same time farmers will be given an opportunity to obtain the assistance of the Soil Conservation Service in applying conservation measures to their cultivated fields, meadows, and pastures.

From one standpoint, therefore, farm forestry projects may be considered as focal centers not only for proper woodland management but for conservation farming in general. Along with soil conservation districts and water facilities areas, they may become a medium for spreading better land-use practices—for extending over a constantly widening area the type of farm plans that have already proved valuable in erosion control demonstration projects and camps.

But in the new projects a great deal of attention will naturally be centered on the woods. Foresters will go into woodland areas with the farmers and help them in working out long-time plans of protection and management. If woodland management is to be effective, fences will need to be erected to keep out browsing, trampling livestock. Firebreaks and trails may be needed to guard against the danger of uncontrolled flames. Deliberate burning of underbrush will need to be discouraged. Scientific thinning will be recommended. Dead or inferior trees will have to be removed, and open areas spot-planted to build up gradually a well spaced and healthy stand.

In addition to timber stand improvement work the program on each individual farm will include a careful schedule of cutting. The farmer will know in advance just which trees to harvest in any year and which ones to leave as capital growing stock. By observing well established forestry principles, he will be able to draw out annual "interest" in the form of a crop of timber and still maintain his "principal" intact.



Remarkable growth in 7½ months of black locust planting on badly eroded old corn field in Nacogdoches soil.

Everything possible will be done to keep young and vigorous trees coming along all the time—to preserve the woods as a reliable asset with the highest possible value.

To the individual farmer taking part in the program, farm forestry work should bring direct and tangible benefits. In addition to better protection for the soil, it should mean a more valuable supply of timber for home use or for sale. Today, with the demand for many wood products constantly expanding, with synthetic fibers assuming a growing degree of importance in our national economy the prospects of financial return for work in the woodlands are perhaps better than ever before. Of course, there are few fortunes to be made from farm forests, but there is a welcome source of supplemental income in practically all well managed ones. And in times of crop failure, a productive woodland may well provide the cash necessary to tide the family through. In any event well managed woodlands should contribute definitely toward greater stability of farm life.

The main significance of the farm forestry projects, however, will lie in their demonstrational value. By helping farmers in a few representative areas to improve their woodlands and develop better methods of management, the demonstrations should start thousands of farmers outside the projects thinking in forestry terms. Since the results of woodland management are not always readily visible, a considerable amount of emphasis will be placed on the keeping of records. Every farmer cooperating in the program will maintain a careful account of his woods—of cash expenditures and cash receipts, of labor devoted to woodland improvement and products harvested for home use. Over the years, it is expected that most of these farmers will build up an impressive case in favor of sound use of woodland on the farm.

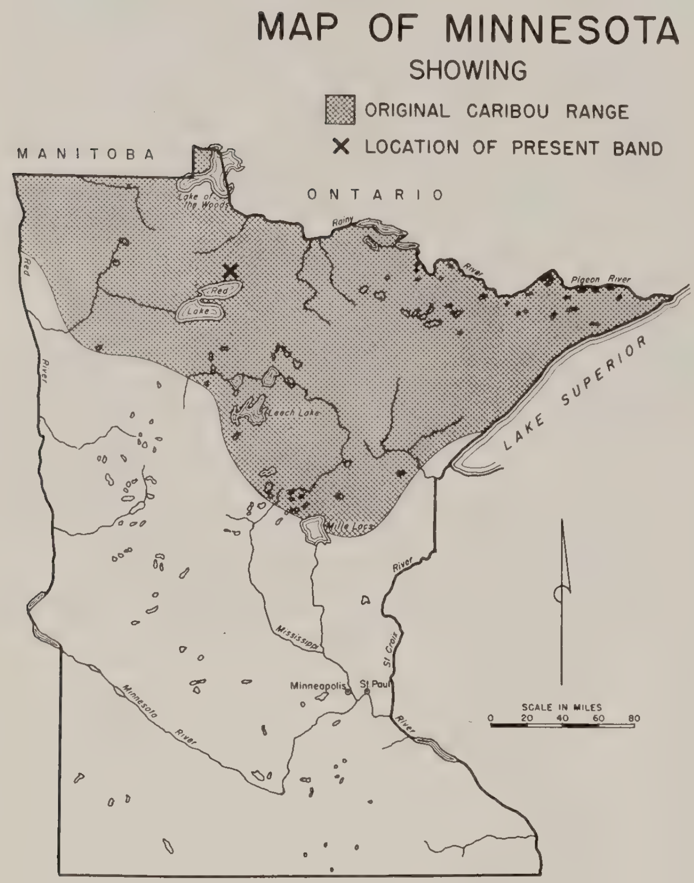
As woodland management begins to assume a more important position in the agriculture of this country, widespread benefits are almost sure to follow. Many idle and run-down lands will be rehabilitated and put to productive use. Source areas for floods and silting will be covered with a soil-protecting, water-absorbing growth of trees and shrubs. Living conditions for wildlife will be greatly improved. With the returns from well-managed woodlands helping to round out the farm income, many farmers will be better able to make improvements and practice conservation over the farm as a whole. In some sections, the reliance on soil-depleting cash crops will be lessened, and the desirable trend toward greater diversification will be intensified.

But all these things, of course, lie in the more or less distant future. Right now the Soil Conservation Service and the other agencies taking part in the farm forestry program face a large-scale job of education,

(Continued on p. 163)

WOODLAND CARIBOU IN MINNESOTA

By WILLIAM T. COX [1]



PERSONS interested in wildlife know well the tragic stories of the passenger pigeon and the heath hen. Not so many years ago heath hens abounded in the New England States, and passenger pigeons were so numerous in the Mississippi Valley that their flight sometimes completely obscured the light of the sun. Today, both species of birds are extinct—destroyed by a wave of remorseless slaughter that will remain always a blot on the sportsmanship of the white man.

But until a few years ago, not many people were aware that a similar fate imminently threatened one of the finest species of big game in the United States: the woodland caribou (*Rangifer caribou-sylvestris*), closely resembling the reindeer of Lapland, has been approaching extinction; the species had in fact almost reached the vanishing point in the United States before anything was done to save it.

Northern Maine and the northern one-third of Minnesota were the original caribou ranges within the United States. At one time from 3,000 to 5,000 animals ranged in Maine, and from 5,000 to 10,000 in Minnesota. The species is believed to have disappeared from Maine over 20 years ago, and only three of the native animals remained in Minnesota before the time of the expedition with which this article is concerned. Even in Canada, where the species was plentiful until recently, woodland caribou have become scarce. The letters that I received from the game guardians of the Provinces indicate that New Brunswick no longer has any caribou, and that the animal is extremely rare in Quebec and Ontario. Although large numbers existed in Manitoba a few years ago, only a few animals now remain in that Province.

Northern Saskatchewan and Alberta are the only Canadian Provinces where fair numbers persist, although Newfoundland still has a good many woodland caribou. There are, of course, large numbers of the barren ground caribou (another species) in the country east of Lake Athabaska and Great Slave Lake; and there are also numbers of mountain caribou of several kinds in British Columbia and Alaska, but the woodland caribou is far on its road to extinction.

When the white settlers came to Minnesota, the State was a close approach to the "happy hunting ground" of Chippewa and Sioux and Cree. Deer were abundant in the southeastern counties, buffalo and antelope roamed the prairies, elk ranged in the "Big Woods" and along the border line of prairie and forest. Moose wandered through the timbered swamps, and woodland caribou, then a populous animal, ranged over the more open bog country.

The sparse Indian population, possessing only inferior weapons, was unable to take any considerable toll of the big game herds. But with the advent of the white hunter the mortality rate of all big game soon greatly exceeded the birth rate. Some species—the buffalo and antelope, for example—quickly disappeared from the State. By 1900, practically all the elk were gone and the caribou were to be found in only a few spots, and there in very small numbers.

It was while I was on a snowshoe and dog team trip through the country north of Red Lake, Minn., in 1913, that it occurred to me that we Minnesotans should make an effort to perpetuate the elk and caribou as part of the native fauna of our State. I therefore asked the legislature to appropriate $5,000, for use in obtaining elk from the Rocky Mountains and building a 700-acre enclosure in Itasca Park and Forest within

[1] Assistant regional biologist, Upper Mississippi Region, Soil Conservation Service, Milwaukee, Wis.

Air view of the black spruce "island" where the last three native woodland caribou in Minnesota over-wintered in 1935 and 1936. The spruce trees are covered with a lichen that serves as winter food for the animals.

which the elk could be given careful protection. The money was provided, the fence built, and the elk obtained. They gradually increased in number and are now well established in a number of places in northern Minnesota.

It was on that same snowshoe trip that I first saw the Red Lake band of caribou, ranging between Red Lake and the Rainy River. There were at that time only 33 animals in the band, and they were feeding in an open swamp or muskeg where occasional clumps of black spruce and tamarack gave partial protection. During the few years prior to my trip there had been a great reduction in caribou numbers, if one may judge from seemingly authentic reports of the number taken out of this locality by Red Lake Indians and by professional hunters who sold the meat in the Red River Valley.

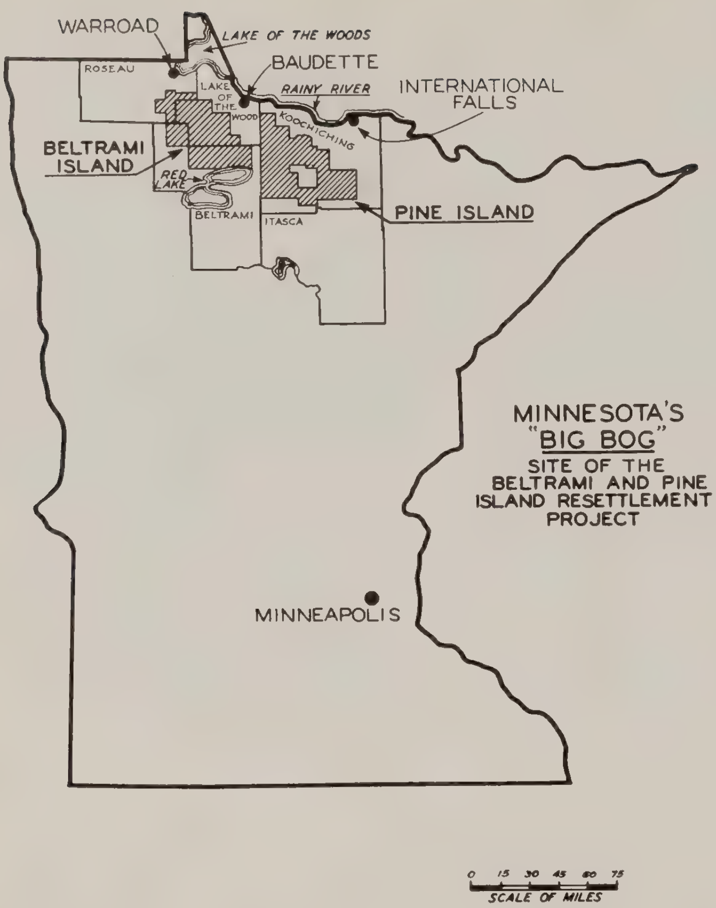
The bands in Aitkin County, and in Cass, Itasca, St. Louis, Lake, and Cook Counties had already disappeared, except for an occasional individual found around Vermillion Lake and in Cook County, and these stragglers were gone soon thereafter.

For a number of years, we in Minnesota encouraged the forest rangers and game wardens to do the best they could to protect the Red Lake band of caribou, but with little success. In 1924, while making an airplane reconnaissance of the timber and wildlife resources of the region between Lake Winnipeg and Hudson Bay, I saw a good deal of the Canadian caribou country. A few months later, in discussing the wildlife of that territory with Dr. E. W. Nelson, then chief of the Bureau of Biological Survey, I suggested to him that woodland caribou for replenishing the Red Lake band in Minnesota be obtained in the Lake Winnipeg district where they were then fairly abundant. Doctor Nelson expressed keen interest in the proposal, but a shortage of funds at the time made it impossible for the Bureau to undertake the capture and importation of the animals.

In 1932, when I was State Commissioner of Conservation in Minnesota, I issued an order establishing the Red Lake Wildlife Refuge of 480,000 acres, with the definite objective of preserving the caribou and other big game in that district. The moose, deer, and beavers increased as a result of the protection afforded by the refuge, but the caribou population continued to decline.

Why the decline?

A number of factors were responsible. I have mentioned the inroads made by hunters, which may or may not have been the chief cause of reduction in caribou populations. Another factor, of perhaps equal importance, was the extensive drainage work done in the "Big Bog" area of northern Minnesota between 1909 and 1922. Hundreds of miles of ditches were dug, and the wet swamps were converted into vast areas of highly inflammable peat lands covered with grass and brush interspersed with cedar and spruce forest. Fires raged through the country year after year, despite strong efforts to control. Many people burned to death, and the toll of wildlife was tremendous. Undoubtedly large numbers of caribou perished in these fires.



The drainage ditches, where they crossed actual muskeg area, were themselves veritable traps for big game. They varied from 6 to 8 feet in depth, were so soft on the bottom that large animals were mired in them, and their banks were steep and high. Rangers often found dead animals in them.

The lowering of the water table, brought about by the drainage program, was another factor tending to reduce caribou populations. Before drainage work was started the cows could find little islands far out in the wet swamp where they could drop their calves comparatively free from molestation by wolves. After the swamps were drained, the wolves could pick up the calves readily without the necessity of swimming or wading to the islands.

Disease and parasites may have been factors influencing the population declines. The fact that in the same territory moose have suffered serious losses through these causes leads one to the conclusion that caribou were also affected, in all probability.

With reference to the rapid decline in the numbers of woodland caribou in Canada, it is of interest to note that Indian reservations in that country are small and numerous. Every 5 or 10 miles through the forest country one finds a few Indian families occupying a tiny "reservation." This system of scattering the Indians works out well insofar as harvesting the fur crop is concerned but it is anything but favorable to the caribou as these easily obtained animals range in so many instances within short sledding distance of the Indian habitations. Since the caribou is easier to get than moose, and about as palatable, it is hunted by the Indians as a source of winter meat.

The Indians, however, are by no means the only threat to the Canadian woodland caribou. Recent years have seen widespread prospecting and mining activity in the wild portions of Manitoba, Ontario, and Quebec; and, as might be expected, large numbers of caribou have furnished food for the prospectors' camps. For 2,000 miles across the continent, from New Brunswick to Saskatchewan, the future looks gloomy indeed for the woodland caribou. Only through intelligent and persistent effort will it be possible to save this splendid animal from extermination. Sanctuaries must be established in places naturally favorable to caribou; thorough protection and intelligent environmental control will be needed. With regard to environment, it should be pointed out that the woodland caribou is "choosy" in its food habits; it needs a variety of browse and moss not found everywhere in the forest country.

The initiation of the Beltrami resettlement project in 1935 seemed to me to offer an unusual opportunity for doing something worthwhile toward reestablishing the caribou in the United States. The project, transferred to the Soil Conservation Service in the fall of 1938, includes the Red Lake wildlife refuge and some 320,000 acres besides. The removal of the scattered and stranded settlers from this territory and their relocation on better land has reduced the losses to big game caused by poaching. Fire hazards have been greatly reduced, not only by removal of settlers but through the blocking of hundreds of miles of useless drainage ditches; the latter has restored marsh conditions and made the area highly productive of wildlife—the soundest land use for this particular territory.

The factors believed to have been largely responsible for the decline of the woodland caribou, and moose also, have been largely removed, and with the completion of the project's development program conditions should be favorable to an increase in all big game, including caribou. In addition, the largest wild-fowl and the best beaver area in the United States has been created and is now functioning so well that it is listed among the "top-notch" wildlife refuges of the country.

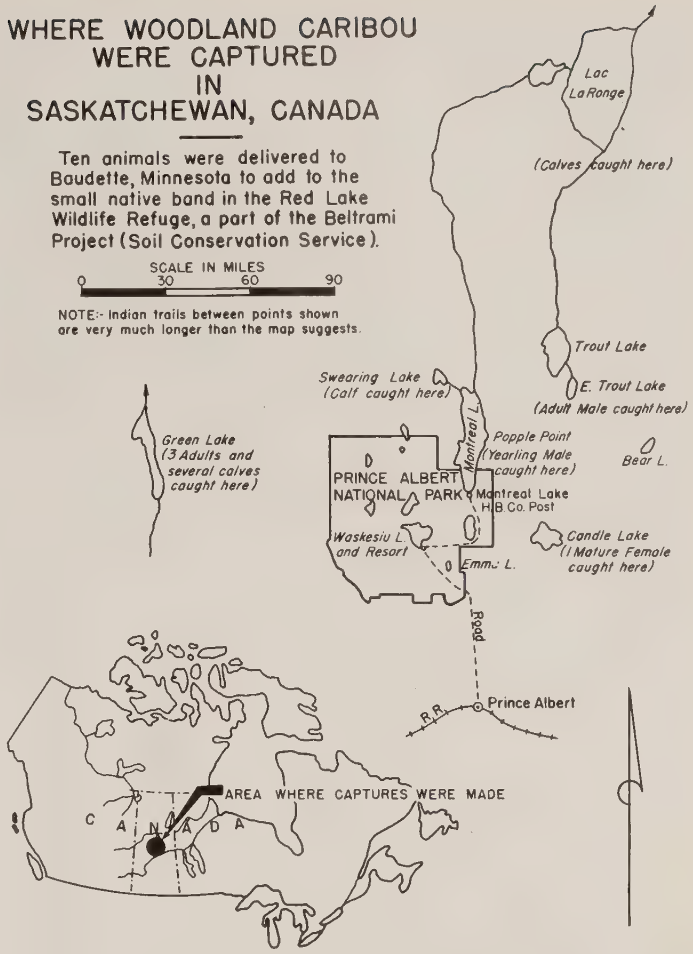
But even after the project was begun, and the wildlife possibilities inherent in its development became clear, the outlook for Minnesota's caribou band seemed dark indeed. The three animals composing Minnesota's band were all cows.

Therefore, I began making plans for restocking the Minnesota range with animals captured in Canada. First of all came the problem of learning enough about caribou range and food habits to ensure a fair measure of success in the proposed venture. It was surprising how little was actually known about the range needs of the woodland caribou, the foods they eat and their general habits. Accordingly, I asked Jack Manweiler, game manager for the Beltrami project, to make a study of the habits and food requirements of the caribou in the Beltrami area.

Manweiler's survey was begun in January 1936 and, believe me, it was no job for a tenderfoot. It was necessary to trail the caribou at all seasons of the year over difficult terrain, and to suffer from severe cold in winter and the severe punishment of insects in the summer. But the job was done, and well done. Manweiler's information has since proved invaluable in the feeding and general care of the captured caribou.

Some of the details of the Manweiler survey are of exceptional human interest. For example, there is the story of the first trip of the group conducting the caribou study—in January 1936. A party of four persons, including Manweiler, two assistant wildlife specialists, and a State trapper left the highway at 5 o'clock one morning with a dog team of seven animals drawing a toboggan carrying food and equipment weighing 400 pounds.

But it is better that the remainder of the story be told in Manweiler's own words: "The snow was deep, making it necessary to beat a trail for the dogs for the entire distance of 14 miles to the first shelter. As the day progressed, the storm turned into a blizzard with a maximum low of –50°. We attempted to follow a ditch grade rather than the open bog because potholes and ditches were filled with drifting snow which



Manweiler and 6 of the captured calves, in June 1938, a few weeks after the trapping expedition which netted 10 caribou for use in restocking Minnesota's "big bog." The calves then averaged 30 pounds each and were kept in a fly-proof enclosure.

192705—39——2

served as an insulation and kept the water underneath from freezing. Even with snowshoes, a step into one of these holes would have proved disastrous, because we should have been unable to secure firewood from the sparse bog vegetation and so could not have dried out clothing.

"The deep snow proved too much for the dog team and it was necessary to leave two of the animals which although they courageously tried to pull their share of the load became paralyzed in the hind quarters. These dogs burrowed into the snow and were rescued 2 days later, when they were found to have no serious injuries; the animals were accustomed to sleeping out of doors and receiving only one meal a day. By 4 o'clock in the afternoon, the party had progressed approximately halfway to our proposed destination—a shelter cabin on a bog pond several hundred feet in diameter and known as Hillman Lake. We stopped for the first rest period of the day and ate a meal of hardtack. Darkness began to fall and the blizzard became more menacing. It was impossible to remain in the open bog for the night, so the journey was resumed.

"While we were crossing an open stretch in the darkness, we lost the ditch grade and an anxious consultation was held at once to decide what our future actions should be. We determined to go with the wind, which was generally from the north, in the hope of finding an island of green timber for protection. Within a comparatively short distance, however, the ditch grade was again located and the journey toward the shelter cabin was resumed.

"By this time, members of the party were helping the dogs pull the load. It is probable that this labor helped save our lives, by maintaining sufficient body temperature. When we closed our eyes against the stinging snow particles, the eyelashes often froze together, making it necessary to thaw them out by applying our bare hands which, of course, soon became numb from exposure.

"By 2 o'clock in the morning—21 hours after we started our trip—we realized that our objective, the shelter cabin, had been passed in the darkness and that it would be necessary to go back through the storm to find it. It was sheer luck that enabled us to locate Hillman Lake and the cabin—22 hours after leaving the highway.

"Luckily shavings and a small amount of firewood had been left in the cabin during an earlier trip—foresight which undoubtedly saved our lives. But there arose the almost unbelievable obstacle of our inability to hold and light a match. After many efforts, we finally ignited a handful of matches and started a fire. Next came the painful job of thawing out. Two hours after our arrival, our socks were still frozen to our boot soles. By daylight, our ears were the size of hens' eggs and we were forced to lance them and apply kerosene to ease the pain.

"Reward for our suffering came almost at once, however. The following morning we sighted the caribou within one-half mile of the cabin—a piece of luck which relieved us of the necessity for many days of search.

"The only other problem at the time was that of finding in the scattered black-spruce swamp sufficient firewood to keep us warm. One week later, when we returned to headquarters, our faces were still splotched with black, frozen skin."

Certainly no job for a tenderfoot!

But I'm sure Manweiler agrees with me that the sacrifices made during the caribou food-and-habit study were more than balanced by the amount of new and useful information obtained. Plans for capture and importation of the caribou were completed.

I found that the only Canadian Province where conditions seemed to justify the taking of caribou for stocking purposes and where a permit to get them could be obtained was Saskatchewan. That Province authorized us to take 10 of the animals—*if we could catch them.* There was a "catch" in the business, both literally and figuratively. However, the United States Department of Agriculture was persuaded to provide the money to pay for the capture and transportation. The State of Minnesota and the Bureau of Biological Survey cooperated, and we finally started field operations about 100 miles north of Prince Albert, Saskatchewan. There the Hudson Bay Co. had generously consented to act as our agent to interest the Indians at Montreal Lake Post in a prolonged caribou hunt to obtain the animals for us.

This was an exceedingly difficult task, much more difficult than catching live moose, elk, or deer. It was necessary that Manweiler go up to Prince Albert and the Hudson Bay Post at Montreal Lake to supervise the taking of the animals, and to see that they were properly fed and cared for afterward. Also, his presence at the post was found to be almost essential to keep Indians out on the hunt, as the caribou were in small bands scattered throughout a large and difficult district.

The work was most discouraging at first. It yielded success later, however, when technique and equipment were improved. But again it is best to hear the story in Mr. Manweiler's own words:

"On March 16 I left Baudette, Minn., for Prince

Albert, Saskatchewan, where a plane was obtained for the remainder of the trip to Hudson Bay Post on Montreal Lake. At the lake, every available convenience was placed at my disposal by the post manager. Meetings with the Indian chief, his counselors, and those trappers who were known to be reliable were immediately held to induce them to take up trapping operations. This was a difficult matter, as the trappers and the Indians were of the opinion that adult caribou could not be taken without injury. Furthermore, no provision had been made to defray grubstake expenses, and the Indians because of their low finances could not begin operations until I had made arrangements to supply food, rope, and other essentials.

"Several days later, the first trapping party, equipped with a week's supply of food, rope, snares, dog teams, etc., established headquarters on the north shore of Montreal Lake, about 35 miles from the post. During that first week no evidence of caribou was discovered. Their disappearance was explained by the fact that extensive fires throughout the preceding summer had caused the animals to avoid their usual haunts; that heavy inroads of timber wolves tended to drive them from the country; and that the mild winter was not conducive to mass migration and concentration.

"Our failure to discover any signs of caribou was disheartening and increased greatly the difficulty of getting additional trapping parties to make an attempt. New territories were explored and fresh signs discovered. New trappers were provided with snares, and additional attempts were made to capture animals. After two of the trappers returned to the base camp, having taken two caribou in snares set at an earlier date, more trappers became interested in the work. Although the first three animals taken escaped, a spirit of optimism developed which, with the assistance of the post factor, was carried through to the end of operations. It was, of course, still necessary to supply rations and rope to all field parties.

"Use of a pitfall to capture animals was entirely unsuccessful; it was necessary to build such pits on caribou trails, where it was difficult to camouflage effectively; and in swampy country water stood a foot or so beneath the moss so that construction of pits was impracticable.

"Rope snares proved the most successful devices for capturing carbou. We were careful to make the snares strong enough to hold the animals, and to design them in such a way that animals would not be likely to become strangled. The first snares set were constructed of ordinary clothesline type of rope, saturated with mucilage. Mucilage was used to "cover up" the rope smell, which would otherwise have frightened away the animals, and to give a smooth surface and so protect the captured animals against rope burns. The choice of mucilage for this purpose, however, proved unfortunate. The first animal captured developed an unaccountable taste for this substance and nibbled at the rope until he was free.

"The rope used in later snares was boiled in a mixture of spruce and cedar boughs and then coated with paraffin. It was necessary to change the location of snares several times during the period of trapping to meet changing snow and water conditions in the peat bogs and highland regions. Though the hunt was continued until June, no attempt was made to capture animals swimming in lakes after ice thawed. Such captures probably could be made quite easily as caribou are often seen swimming and can be approached by canoe.

"All in all, 18 adult caribou were taken in snares. Three of them were released either because trappers misunderstood the sexes desired or were afraid of the enraged animals. Eleven animals escaped. Four adults were finally brought to Montreal Lake headquarters. Two of the four adults died, one from injuries caused by a trapper's dog which preceded the trapper to the snare, and the other from the results of improper handling on the part of the trappers.

"Work was continued through June and eventually 10 animals were taken, 8 of them calves. These were transported by truck from Montreal Lake to Prince Albert, by express to Baudette, and then by truck 35 miles to Ludlow Island in the Beltrami project. There, the animals were placed in a corral and quickly became reconciled to their new surroundings. One of the eight calves died, but the remaining seven are doing well. Each calf weighed approximately 22 pounds when captured. The calves now average approximately 200 pounds and are in fine condition.

"The largest animal captured, a male weighing 350 pounds, was kept in the corral only 6 months. At the end of that time, he was transported by a caterpillar tractor through 12 miles of bog and released in an enclosure covering 4 square miles of bog land and constructed of a seven-strand barbed wire fence 7 feet high. He was allowed to range there until the first part of October, at which time he was liberated to join the three native cows that were in the immediate vicinity. The last sign of this animal was noted in February 1939, nearly a year after the date of capture. At that time, he was ranging with the native cows.

(*Continued on p. 156*)

SNOW SURVEYING

By JAMES C. MARR [1] and PAUL A. EWING [2]

Removing snow-sampling apparatus from canvas carrying case preparatory to use. (Photo courtesy U. S. Forest Service.)

SNOW is water, and water is wealth.

These are axioms in the West, where most of the year's precipitation falls in the winter months and the summers are dry. Western farmers, great cities and the corporations that manufacture electric energy through the medium of falling water, all watch the accumulation of snow high in the Rockies, the Cascades and the Sierras, quite as jealously as they scan their bank or treasury balances, even though the snow itself may be hundreds of miles away. Indeed, if those distant snow deposits are low when spring is at hand, bank balances are pretty sure to suffer too, before the summer ends. But when "at the summit" great depths of snow are reported in late winter, the West is optimistic, for then the long dry summer holds no serious threat of drought. Its heat will melt the treasured snow and abundant water will come down from the mountains.

When will it come? How much will there be? It is easy to say that the snow falling at this very moment on some high watershed presently will become a natural storage reservoir from which some low fertile valley will derive its summer water. It is not yet possible to say just when, just what amount; but while the amount of run-off from a watershed cannot be predicted merely from meteorological measurements of the snow that falls, dependable forecasts of seasonal run-off can be made from measurements of the snow pack after the accumulation of snow has reached its maximum. For more than 30 years such forecasts have been made on the data obtained from measurements of the water content of winter accumulations of snow. The accepted method of making these measurements is termed "snow surveying."

[1] Irrigation engineer, Soil Conservation Service, Boise, Idaho.
[2] Irrigation economist, Soil Conservation Service, Berkeley, Calif.

Up to 1935 successful forecasts based on snow surveys were made for most of the principal watersheds in Nevada, Utah, and California. Some forecasting was done also in Oregon, Idaho, Wyoming, and Washington. In later years, since July 1, 1935, there has been under way a program authorized by the Federal Government to extend and unify the activity throughout the 11 Western States. The services of a large force of about 2,000 responsible and experienced men are needed to make the surveys simultaneously at widely separated points over a vast region at designated times during the winter months. Many of these observers are employees of various Federal, State, and municipal agencies, power companies, and irrigation enterprises without whose cooperation the work could not be carried out successfully on so large a scale.

The procedure for determining the water content of snow consists essentially in procuring cores of small diameter, vertically, from the snow cover at the designated points along a snow course and weighing them. A metal tube, designed especially for the purpose, is used to obtain the cores. The diameter of the snow core is such that its weight in ounces is equivalent to inches of water; that is, a core of snow weighing 1 ounce represents 1 inch of water in a cylinder of the same diameter. Thus snow depth is quickly and accurately converted into the more significant figure, water depth, simply by weighing the cores, and a measurement made in this manner discloses the depth of water in the snow mantle at a properly located sampling point.

The accuracy and rapidity with which the water-content measurement is made with standard snow-sampling equipment gives this procedure a practical advantage over other known methods of making such measurements, particularly when the measurement must be made in the high, isolated mountain areas during the winter.

Obviously, it is difficult from observations of snow depth made in snow-stake recordings to estimate ac-

There are now more than 7,000 farms—approximately 2,000,000 acres—cooperating with soil conservation districts in fighting erosion. These farms are scattered through 116 districts in 23 states.

curately the water content of the snow cover, especially when it is deep and laminated, and the observed depth of snow alone is inadequate as a basis for forecasting run-off.

The arduous and time-consuming practice of gathering samples of the snow cover and melting them to determine water content is also made unnecessary by the quicker, easier, and more accurate way in which the measurements are obtained with standard snow-sampling equipment.

If a reliable forecast is to be made from the measurement of the water content of the snow, certain requirements must be observed:

1. *Measurements must be made at elevations where little or no melting occurs until after April 1.*—The snow surveyor may have to travel far into the mountains to reach elevations where snow will not have melted materially by the time of the April survey. There are other reasons also for placing snow courses high in the mountains, but this one alone justifies the difficult winter trips sometimes required to reach these elevations.

2. *The snow course must be sufficiently accessible to insure continuity of the surveys.*—Great care should be exercised in finding the most accessible location when a snow course is established, especially if it is a high one. If after a course has been established another location just as good is found, it is not advisable to change the location because the change destroys the continuity of the records on which the forecasting is based.

3. *Measurements must be made at a sufficient number of fixed points on an established, marked course to insure that the average of such measurements will not be unduly affected by drifting or wind-swept snow.*—Snow surveyors find little similarity in the design of snow courses, and many wonder why some are longer and call for more measurements than others. Each course is planned definitely to permit a group of measurements, the average of which will represent the snow cover at the given elevation and exposure. The topography and the presence or absence of forest cover account for wide variations in the design of courses.

For example, an open place may be found in the forest, nestled among hills and protected from high winds, and large enough so that snow may fall to the ground without being intercepted. If the snow falls and lies uniformly over this area, a few measurements, made either as a group in one open space or separately in several adjacent open spaces, will yield the desired record. If the open space is large and of a shape that might permit the snow to shift within it, the only sure plan to follow is to make a series of measurements along lines that form a cross or an ell or otherwise so arranged that the average of the measurements will represent the snow cover within the area.

If protection from wind is altogether lacking and the course must be in the open, the measurements should be taken over an area of at least one-half square mile. A small area cannot be selected with assurance that the average of any number of measurements made within it will indicate the average snow cover for the locality. Since sufficient knowledge of the tendency of the snow to drift if unobstructed and the direction in which drifting will occur is lacking, it is expedient to provide for an extensive survey having long courses and a large number of snow measurements. Once the prevailing length and direction of snow drift has been ascertained it may be possible to shorten these courses, but probably they will always have to be relatively long and many snow measurements will have to be made.

4. *Surveys must be made on a sufficient number of courses properly located on each watershed to cover the variability of storms over the watershed.*—A snow survey should show the amount of snowfall accumulated during the preceding winter months. It is important therefore that surveys be made at the time of year marked by termination of winter storms, because not until then can there be assurance that the snow mantle has reached a maximum for the year, nor can the final and most important forecasts of the year be made.

The general program in the Western States calls for a survey about the 1st day of each month from January to May, inclusive, on a limited number of key courses and surveys at all courses on March 1 and April 1. If a survey can be made on only one of these dates, April 1 is preferred. The schedule is thus ordered particularly to make possible the regular water-supply forecast service, required for efficient operation of irrigation projects, municipal water works, and hydroelectric plants. It is more than adequate to serve other purposes as well, except for the need of the northwest coastal section to know snow conditions throughout the winter so that its typically erratic winter floods may be guarded against. A schedule for this coastal section has not yet been adopted.

While the most important date in this schedule is the time of the year marked by the termination of winter storms, this date actually varies somewhat from place to place and from year to year. It may be March 1, April 1, or some intervening date. It has been impossible to fix a date that all snow surveyors

Shelter cabin with tower ("Santa Claus chimney") to permit entrance when cabin is buried under deep snow.

will recognize as best for their sections as well as proper for a large region such as the Columbia River Basin.

Furthermore, the forecast service, like the surveys, must follow a rigorous time schedule. Actually, only timeliness is sacrificed by fixing April 1 as the date when the surveys are made on all courses and when the final and most important forecasts of the year are announced. If the courses are properly located, the snow lying on them the first of April will still represent the winter's maximum snow mantle in water content, even though snow at lower elevations has melted to some extent and some run-off has already occurred. At least there may be assurance at this time that the winter storm period is practically over and that the movement of the snow will be very near to the maximum for the year. Nevertheless, meteorological developments may prove that forecasts as of April 1 might have been made with equal accuracy 1, 2, or 3 weeks earlier, and since there is need for this information as early as it is obtainable, the March 1 surveys have considerable value. As a basis of tentative forecasts they should be as complete as possible for all courses.

Less effort to procure complete information in making snow surveys on January 1, February 1, and May 1 is usually warranted. One key course on each important tributary of a major drainage basin may yield satisfactory data, but measurements are taken on more courses if the cost and effort required are small. They are useful as a means of following developments in water-supply conditions throughout the winter and early spring months. January 1 surveys are relatively least important and may be omitted if a long trip is required and soft snow makes travel difficult. May 1 surveys are particularly useful because they indicate prospects for late-season run-off.

Though the 1st day of the month is specified for making the surveys, a reasonable variation is permissible and frequently necessary; hence a period of 4 days before and 4 days after the 1st of the month (8 days) is prescribed as that within which the surveys should be made. If difficult travel into high country is required, it is expedient to take advantage of cold-fair weather for the trip. It is better that these data be procured several days before rather than after the 1st of the month to insure their prompt publication and use.

Locally there may at times appear to be little need for a survey, but always somewhere downstream are conditions that make maintenance of the time schedule necessary.

Water-supply forecasts based on snow surveys are made on the assumption that there is a simple relationship between the water content of the snow cover of a watershed and the run-off from the watershed. Such forecasts can be made more simply and accurately if the major part of the precipitation occurs as snow at high altitudes, where there is little or no melting. For any watershed for which dependables snow-survey data and run-off data are available representing several consecutive years, a chart can be designed from which an estimate of the run-off, for a determined storage of water in snow, can be made. Such a curve will, of course, apply only to the watershed from which the data were secured and should be recalculated as the observations become available.

The desirability of making the maximum use of water in irrigation, and the variation in the amount available from year to year, call for water-supply forecasting. An accurate forecast guides farmers in planting their crops and permits efficient operation of irrigation works.

Snow-survey data indicate the probability of floods. Other factors, such as temperature variation from normal and occurrence of heavy rainfall, must be considered with snow-cover conditions in predicting when floods will take place and the heights to which the water will rise. The River and Floods Division of the United States Weather Bureau, the Corps of Army Engineers, and other governmental units similarly concerned with floods are promptly supplied with all snow-survey data. If the accumulated snow cover is determined to represent a potential flood hazard and reservoir capacity is available, immediate steps may be taken to prevent possible disaster by operating the reservoirs as flood-control works. In most cases the reservoirs are used to store water for irrigation, power, and water-supply purposes, which require that they be filled during the spring run-off period. Water-supply

forecasts based on snow surveys make it safe, however, to use them to good effect as flood-control works, with assurance that they will fill.

Many power companies have long employed snow surveys to obtain indicators of stream flow on which to base operation schedules. The procedure is especially necessary where water is used for both irrigation and generation of electric power. For instance, at Boulder Dam the economy of generating as much firm power as possible on a continuous basis and at the same time retaining enough water for irrigation makes it necessary to know in advance how much water the mountain snow cover will yield.

Much importance is attached to snow-cover data, particularly by the United States Forest Service, as an indicator of forest fire hazards and grazing conditions. Prolonged drought increases the danger of disastrous forest fires and diminishes feed for livestock and wildlife on the range. Any indications that forests will be dry afford an opportunity to put into effect measures that aid in preventing and controlling fire and in avoiding the overstocking of the range.

Water is so scarce at times on some range land that the flow of springs is the factor limiting the use that may be made of the feed. Correlation of the past performance with snow-cover data afford a proper basis for granting grazing privileges.

Cities such as Los Angeles and Denver, which depend upon storage, stream flow, or springs for water, are benefited by and rely confidently on forecasts based on snow surveys.

The ease with which snow densities may be ascertained with standard snow-sampling equipment has prompted its use for determining the snow load that structures must be designed to withstand, and density measurements are being made with snow-sampling equipment in order that power necessary to open snow-bound roads may be gaged accurately.

The Federal land banks and similar credit agencies study the forecasts in order to restrain or encourage farm operations that may affect the ability of farmers to meet their financial obligations.

The Federal Crop Reporting Service, and other agencies concerned with statistics relating to crop production, use snow-survey measurements as indicators of the types of crops that will be planted on irrigated land and of prospective harvests. Promise of an ample supply of late water leads to the planting of late maturing crops, whereas only early maturing crops will be grown if it is known that the water supply will be short, especially during the late growing season. Moreover, the amount of water to be available is the major factor limiting crop yields. Thus irrigation water-supply forecasting is helpful in predicting not only unit yields but also the acreages of various crops.

The water supply is frequently a chief concern in planning the operations of mines, especially placers, and in smelter operations; data obtained in the snow surveys are accordingly of considerable use to the mining industry.

The Migratory Waterfowl Division of the United States Biological Survey maintains numerous inundated areas throughout the West as feeding grounds and refuges for wildlife. Elaborate systems of dikes and diversions have been required for regulating the depths of water and for extending or restricting most of the flooded areas in accordance with amount of water available. Water-supply forecasts based on snow surveys are useful in effecting the best operation of these systems.

In brief, the water-supply outlook is of general interest throughout the West because people interested in production, trade, shipping, banking, and employment all follow the water-supply trend somewhat closely. In an article to appear in a later issue of Soil Conservation, the authors expect to describe the manner in which the field work of snow surveying is conducted, the apparatus used, and some of the problems the men engaged in the work have to face and overcome.

Snow surveyor reading depth of snow on snow tube scale.

FACTORS AFFECTING RUN-OFF FORECASTS BASED ON SNOW SURVEYS[1]

By W. W. McLAUGHLIN[2]

WATER-SUPPLY forecasting, by means of snow surveys, is a relatively recent engineering development in the field of soil and water conservation and use.

Snow surveys consist essentially of measuring the amount of water held in storage as snow on the ground at permanent locations on mountain watersheds. They are the universally recognized bases for estimating the water potentialities of mountain snowcover.

Snow surveying for water-supply forecasting is practiced, perhaps most importantly, in the arid and semiarid country lying westward of the Mississippi River. Its adaptation to water-supply forecasting was initiated here more than 30 years ago. Since then it has been perfected and its utility for the purpose proved to the point where it is generally conceded to be the best means for forecasting water supplies in this region, where climate and topography make an ideal setting for demonstrating the utility of snow surveying. For the most part the climate ranges from arid to semiarid. It is further characterized by a dry season which coincides with the growing season. The topography comprises broad valleys and high mountains. In the valleys lie the principal opportunities for human occupation with the exception of limitations imposed by dearth of water. The mountains yield practically all the water. Upon them falls as snow during the winter season the greater portion of the meager annual precipitation of the region. At elevations ranging from 3,000 to 12,000 feet the snow accumulates to depths of 4 to 20 feet or more by spring. With commencement of the dry season and subsequently, this snow melts and feeds needed water directly and through the ground into the water courses. The irrigation of nearly 20,000,000 acres of land depends upon this water as does the operation of huge hydroelectric plants. It is important to know how much water will be available for these and other purposes. Obviously the setup favors looking for this information in the mountain snow pack.

It might appear that water-supply forecasting in this case would be a simple matter of following the precipitation trends and judging water prospects accordingly. We know by experience, however, that ordinary meteorological data and methods do not serve our purpose well enough. The intervening time between the occurrence of precipitation and the appearance of flowing water antiquates snow and rainfall data too much. Profound changes in amount and form of the water precipitated and in watershed conditions take place during this interim. We have found it necessary instead to determine the characteristics of the ultimate snow pack and to take into account the final condition of the watershed. This is an imposing engineering undertaking involving the use of especially devised instruments and technic, difficult field work, and the services of an army of trained snow surveyors.

However, the course method of snow surveying is not an attempt to determine quantitatively the actual amount of water stored on any particular watershed in the form of snow, but rather to establish the relation between the snow cover at certain definite locations and subsequent stream run-off from the watershed, not alone for the season but by semimonthly intervals during summer and fall. The utility of the method lies in the fact that most of the winter's effective snowfall occurs in a few heavy storms which usually are uniform in intensity over large watersheds. Thus a relatively few properly placed courses will accurately reflect the watershed snow cover in comparison with the cover of previous years. It may be assumed, all other conditions being equal, that there is a definite determinable but not direct relation between the water content of the snow as measured on the courses and the subsequent run-off. The method becomes more accurate with each year's additional snowfall and run-off records. Such correlations may be attempted after 3 years of records are secured, but will show more promise of success if delayed until at least 5 years' records have accumulated.

In the simple case, unaffected by disturbing factors to be discussed later, the relation may be shown conveniently and clearly by plotting the snow-water content of the final spring survey (usually taken about April 1) each year as an ordinate with the corresponding resultant run-off as an abscissa. A smooth curve (often nearly a straight line) may then be fitted to the data either by eye or by the method of least squares and used in forecasting the run-off from snow survey data. However, when there is a complication or an un-

[1] Paper prepared for International Commission of Snow and Glaciers, Washington, D. C., September 1939, and printed in SOIL CONSERVATION by special permission.

[2] Consulting engineer, Soil Conservation Service, Berkeley, Calif.

Snow surveyor weighing snow tube and snow core.

usual year, then other factors must be taken into account. It is these unusual years when accuracy of forecasts is most essential.

Where several snow courses on one watershed are measured, the average of all may be used. In other cases, the watershed may need to be elevation-zoned and courses in each elevation zone averaged and the separate zones weighted according to the percentage each bears to the whole. Similarly, it is sometimes found that better results are obtained by weighting individual courses. Each watershed usually proves a law unto itself in this respect and preparing the correlation curve at times becomes an empirical process of trial and error.

Correlation curves are influenced by the combination of at least 10 variables. These variables fall into two groups, the first, watershed variables, and the second, climatic variables. Physical characteristics of any individual watershed are practically constant, but the climatic factors that induce divergence vary from year to year. The two groups of variables cannot be exactly separated in practice because the former is a long-time product of the latter and direct effects of the latter group may be masked by variations in the former. However, for purpose of this discussion, we may arbitrarily differentiate the two groups of variables as follows:

1. Assuming climatic factors as normal each year, the form of the correlation curve for any individual watershed would be influenced by the following factors:

A. Geographical location of watershed.
B. Watershed elevation.
C. Watershed topography.
D. Vegetative cover.
E. Depth and character of soil and underlying formations.

2. Assuming the above watershed factors as unchanging from year to year, the climatic variables which would influence the annual adjustments of the basic correlation curve are:

A. Elevation limits of the snow mantle.
B. Precipitation during the winter season.
C. Precipitation during the run-off season.
D. Watershed subsurface water content at beginning of the run-off season.
E. Climatic trend.

In the first group (watershed factors) the geographic location of the watershed governs the general nature of the relationship between accumulated snow cover and stream run-off, because of the wide divergence in the proportion of the stream flow coming from melted snow in different areas.

Watershed elevation is important in determining percentage of total annual precipitation that will accumulate as snow, higher elevations generally converting a greater percentage of total precipitation to snow. Consequently, total precipitation is more readily determined by the snow-survey method on high watersheds. Usually too, the snow at the highest elevation is the last to melt; therefore, high-elevation watersheds can be counted on to deliver late summer water to streams, whereas low-elevation watersheds deliver a far greater percentage of their snow cover to early summer stream flow.

Watershed topography is important because water from melting snow is more rapidly and more completely delivered to streams from watersheds of steep topography. The more rapid and complete the delivery of water, the higher the correlation between the snow measurement and total resultant stream flow. However, where rapid and complete delivery of water is made, it is often at the expense of sustained low stream flow during late summer months. Therefore, precipitous watersheds generally are poor equalizers.

The snow cover run-off correlation is directly affected by watershed vegetative cover. This effect is threefold: first, as it affects the amount of snow reaching the ground; second, as it influences the rate at which the snow cover melts; and third, as it affects the quantity of water absorbed by the soil. Brush cover, common to western high plateaus, is effective in accumulating snow, but does not effectively retain it. Dense forest cover is effective in retaining snow on the ground, but intercepts relatively large amounts of snow on the tree crowns, and an important part of the intercepted snow may be evaporated back into the air. Connaughton[3] concluded from his and similar studies that even though maximum watershed yield is obtained from denuded areas, open forest cover, without unduly reducing by interception the amount of snow reaching the ground, so retards rate of snow melting that watershed yield is beneficially stabilized. He defined the ideal forest cover as one "honeycombed by 'glades,' whose extent is so related to height of trees that little direct sunlight reaches the snow."

[3] Accumulation and Rate of Melting of Snow, By C. A. Connaughton. Journal of Forestry, Vol. 33, No. 6. 1935.

Mountain water storage occurs in two forms. The first and most obvious perhaps is the enormous storage in snow. Appreciable though less important storage is found below the ground surface, either in the soil mantle or within caverns or interstices of the underlying formations.

Watersheds differ widely in this respect. Portions of the granitic Sierra Nevada range are covered with such a shallow soil mantle and the parent material beneath is so lacking in voids, that relatively little watershed storage other than in the form of snow takes place. Contrasted to this are the lava formations of the Cascades in Oregon and Washington where an immense amount of water is annually stored below the ground surface. Subterranean storage is so great in certain parts of the Cascades that many fair-sized streams originating from subterranean galleries have a near-maximum flow when they first appear on the surface. Springs from which these streams first appear sometimes show an increased rate of flow beginning in October. This might indicate that water from melting snow, either of the current or preceding year, is only then finding surface outlet. On those watersheds preparation of the forecast curve must not only give weight to the current years' snow-water supply, but the previous 2 years' snow supply as well. One correlation weighting used in the Cascades ascribes a weight of 100 to the current year's snowfall, 50 to that of the year before, and 20 to that of the year before that.

Water stored in watershed soil does not by itself contribute to the flow of streams, because water so held is only removed from the soil by evaporation or by plant roots. However, after a watershed soil is filled with water to its field capacity, additional water from the melting snow must either percolate through, to reappear later in the flow of streams, or flow over the ground surface to the closest concentrating channel. Therefore, the capacity of watershed soils for holding moisture is most important in determining what percentage of the snow cover will be required to "prime" those soils, and what residual percentage, if not evaporated, will be then free for direct delivery to streams. A deep dry soil will absorb a large percentage and a shallow wet soil practically none. Between these extremes, any number of soil conditions may exist. Determination of these subsurface water conditions is part of the snow survey program, and already in Utah and Oregon watershed soil-moisture determinations have been included in the snow measuring work.

In the second group (climatic factors), annual variation in the accumulated winter snow-water content is not included, for, all other climatic factors being equal, the annual water-content variations themselves in conjunction with the watershed variables, define the correlation curve.

Deviations from normal of any one of the five climatic variables listed may make necessary an adjustment of the correlation curve. These five variables may be further separated into those which may be considered and allowed for in making up forecasts and those which are not effective until some time after forecasts are issued. These latter are really the most disturbing for they cannot be foreseen or guarded against, yet at times they greatly distress the forecaster by their destructive effect on forecast accuracy.

Heavier than normal snowfall at lower elevations, with consequent lowering of snow lines, does not necessarily mean that snowfall at higher elevations will also be greater. Snow course measurements will of course show whether or not this be the case. Similarly, in the reverse, high-elevation snow may be disproportionately great in some years. In either case the elevation zone weighting method previously referred to in this paper will absorb the abnormality.

The unpredictable climatic factors which by their variance from normal may play havoc with forecasts are precipitation, and temperature and wind movement (factors influencing snow evaporation and rate of melt) during the run-off season. Both factors exert a profound influence on run-off from snow fields. If no precipitation occurs during the run-off season, stream flow may be reduced as much as 50 percent from that which otherwise might be expected. Run-off may be similarly increased by over-much rainfall during this period.

Dry, warm, downslope winds, commonly called "chinook," may take heavy toll of snow in the Rockies and mountains of the Pacific Northwest. This wind in Switzerland is called the "snow eater." A prolonged "chinook" may radically change the snow run-off correlation in a relatively short time by evaporating the snow without increasing run-off. High temperatures, on the other hand, may likewise accelerate evaporation, but at the same time they increase the rate of melting of snow, thus hastening the rate of delivery of snow water to streams and creating early run-off. This is sometimes advantageous where run-off waters are impounded behind dams for future use or irrigation by flood water only, as a greater snow-field yield is secured by rapid run-off. Where means of conserving flush stream flow for later use are lacking, abnormally high temperatures are not desirable because late season water supplies are dissipated before their time of need.

The effect of climatic trend is most closely associated with climatic factor D, inducing either a progressive drying or moistening of the watershed soil, depending on the trend. The trend likewise may be toward decreased or increased precipitation during the run-off season. The effect of trends appears to become less pronounced after the first year or so, when the most marked deviation of the correlation curve will be noted.

Another climatic factor which may be responsible for annual shifting of the correlation curve is variable watershed soil-moisture content and ground-water storage at the beginning of the run-off season. This factor is interrelated to watershed factor E previously discussed. If watershed soils are dry and the water table is low, the effect is to shift the basic correlation curve to the left. Unfortunately, we are not far enough along with the procuring of special data for determining the state of soil moisture and ground water to show whether or not they will serve our purpose.

A full description of how the April precipitation is used to correct forecasts based on snow surveys made a month earlier on Upper San Joaquin River appears in the Transactions of the American Geophysical Union Nineteenth Annual Report.[4] In this as in most cases a wide departure from the normal spring precipitation must occur to make it necessary to correct the April 1 snow-survey water forecast, but there should be preparedness when occasion arises to do so. Fortunately, this does not occur very often, since it is usually urgent that the April 1 forecast be reasonably accurate.

As a rule, our forecast error is less than 10 percent when based solely upon the depth of water found in the ultimate mountain snow pack. However, occasionally we find that the error is exceeded or that 10 percent is excessive. In such cases it is necessary to give attention to some of the other factors, such as the depth, character and water content of the soil mantle, depth to ground water, etc. In these and other respects each watershed presents a different problem. At present we are amidst research aimed to determine, in each case, the watershed factor that will give without fail the desirable final touch of refinement to our forecasts. This correction factor is being sought in the state of soil moisture that exists on the watersheds each

(*Continued on p. 163*)

[4] Development of Snow Surveying in California. By Fred H. Paget.

QUANTITATIVE BASIS FOR EVALUATING EFFECTIVENESS AND APPLICATION OF SOIL CONSERVATION PRACTICES

By R. E. UHLAND [1]

TECHNIQUES for accurately evaluating the effectiveness of soil conservation practices have long been needed. Variation in the fertility of soils, within and between soil types, in degree and length of slope, and other factors must be taken into account in planning for effective erosion control. If a planned soil conservation program for a field or farm is to be accurately evaluated as to effectiveness and practical application, such a measure in its final summation must be in terms of crop yields with consideration given to whether the land is being used wisely, and if the permanency of the soil can be assured. Once a reliable measure of the erosion effects on crop yields can be attained it becomes a simple matter to reflect the values of soil conservation practices and the necessary accompanying farm reorganization in terms of immediate and possible future crop yields. When the effects of different degrees of erosion as represented by various depths of surface soil are portrayed by different crop yields, then it is necessary only to evaluate a practice in terms of time to erode an inch of surface soil in order to be able to predict the degree of permanency of the soil and the rate of modification of crop yields.

Fortunately experimental data are available concerning the rates at which soil is lost by water erosion. These data have been secured on 11 Federal and State cooperative soil erosion experiment stations over a period of time varying from 21 years on the Missouri State Experiment Station at Columbia, to approximately 10 years for most of the cooperative stations.

An analysis of these data shows that the conditions represented vary widely with respect to soil types and fertility, length and degree of slopes, vegetative covers, and cultural treatments. According to these data the vegetative cover, which was markedly influenced by soil type and fertility, exercised the greatest effect on soil and water losses. The degree and length of slope as well as cultural treatments, as would be expected, influenced greatly the rate at which soil erosion occurred.

A complete analysis of these data has been made and the results are set forth in table 1. It will be noted that the crops are grouped into 4 major classes: (1) intertilled crops, (2) small grains, (3) legumes and grasses, and (4) meadow or pasture. These groups are, in turn, subdivided in accordance with the sequence of the different crops. The figures listed represent erosion factors. They are the percentages of the top 7 inches (1,000 tons) of soil that are lost annually through erosion by water for various crops in cropping systems grown on soils representing different degrees and lengths of slopes. The factors marked with asterisks on the table were obtained experimentally on the experiment stations cited above. The remaining values were carefully calculated by extending the above values and by supplementing them by extensive observations made in carrying out evaluation surveys and field tests. These calculated values may be adjusted and refined as rapidly as experimental findings and experience indicate the need and justification.

The values listed in table 1 are for soils that have been under cultivation for a considerable period of time. These soils had lost from 25 to 50 percent of their surface soil and about one-third of their original nitrogen and organic matter. For soils that have lost less than 25 percent of their surface, the factors for the A slopes should be one-half the amount listed. Those for the B slopes should be the amounts listed for the A slopes. Those for the C slopes should be those given for the B slopes, and for the D slopes, the C values should be used throughout the table.

For those soils that have lost more than 50 percent of their surface soil, all values listed should be increased by 25 percent, since the erosion losses are known to become increasingly severe as erosion progresses. For soils showing little need for lime and little response to fertilizer or manure, credit should be given for the use of those soil amendments in determining the efficiency of soil-conservation practices on that farm or field.

By means of the values presented in table 1, it becomes a simple procedure to determine or to evaluate the effectiveness of soil-conservation practices planned for any individual field or farming area. To facilitate this evaluation there are listed in table 2 six efficiency rankings based on the rate at which the loss of the surface 7 inches of soil may be reduced and the life of the soil extended. In this consideration, the efficiency rating for soil conservation was arbitrarily

[1] Liaison officer, divisions of research and operations, Soil Conservation Service, Washington, D. C.

TABLE I EROSION FACTORS EXPRESSED IN PERCENTAGE OF TOP SEVEN INCHES (1000 TONS) OF SOIL LOST ANNUALLY THROUGH EROSION BY WATER FOR DIFFERENT CROPS OR CROPPING SYSTEMS ON DIFFERENT DEGREES AND LENGTHS OF SLOPE

Supporting Treatment		1				2				3				4			
System of Cropping or Land Use (a)	Average Length of Slope (c)	Crop or Rotation without supplemental practices				Crop or Rotation ✓ lime & fertilizer (including manure innoculation as needed)				Crop or Rotation Plus Contour Cultivation				Crop or Rotation ✓ lime & fertilizer ✓ contour cultivation			
		Slope Class A	B	C	D	Slope Class A	B	C	D	Slope Class A	B	C	D	Slope Class A	B	C	D
Planted annually to intertilled crops (3 or more years)	Short	*2.0	*4.0	*8.0	*12.0	1.5	*3.0	*6.0	*9.0	1.5	*3.0	*6.0	9.0	1.0	*2.0	*4.0	6.0
	Medium	4.0	8.0	12.0	16.0	3.0	6.0	9.0	12.0	3.0	6.0	9.0	12.0	2.0	4.0	6.0	8.0
	Long	6.0	12.0	16.0	20.0	4.5	9.0	12.0	16.0	4.5	9.0	12.0	16.0	3.0	6.0	8.0	10.0
	Extra long	8.0	16.0	20.0	24.0	6.0	12.0	16.0	20.0	8.0	14.0	18.0	22.0	6.0	12.0	16.0	20.0
Intertilled crops alternated with small grains (maximum of 2 years)	Short	*1.5	*3.2	*6.5	10.0	1.3	*2.0	*5.0	7.0	1.3	*2.0	*5.0	7.0	1.0	*1.5	*2.0	4.0
	Medium	3.2	7.0	10.0	13.0	2.5	5.0	7.0	9.0	2.5	5.0	7.0	9.0	1.5	3.0	4.0	6.0
	Long	5.0	10.0	13.0	16.0	3.5	7.0	9.0	12.0	3.5	7.0	9.0	12.0	2.0	4.0	6.0	8.0
	Extra long	7.0	13.0	16.0	20.0	4.5	9.0	12.0	15.0	6.0	11.0	14.0	18.0	3.0	6.0	10.0	16.0
Intertilled crops in rotation with small grains, legumes & grasses (b) (maximum of 2 years)	Short	*1.0	*2.0	*4.0	*6.0	1.0	*1.5	*3.0	*4.5	1.0	*1.5	*3.0	4.5	1.0	*1.2	*1.5	*2.0
	Medium	2.0	4.0	6.0	8.0	1.5	3.0	4.5	6.0	1.5	3.0	4.5	6.0	1.2	2.0	3.0	4.0
	Long	3.0	6.0	8.0	10.0	2.3	4.5	6.0	8.0	2.3	4.5	6.0	8.0	1.5	3.0	4.0	6.0
	Extra long	4.0	8.0	10.0	12.0	3.0	6.0	8.0	10.0	3.0	6.0	8.0	10.0	2.0	4.0	6.0	10.0
Intertilled crops in rotation with small grains, legumes, grasses (maximum of 1 year)	Short	*0.9	*1.5	*2.5	4.0	*0.8	*1.0	*2.0	3.0	0.8	*1.0	*2.0	3.0	0.6	*0.8	*1.0	1.2
	Medium	1.8	2.5	4.0	6.0	1.5	2.0	3.0	5.0	1.5	2.0	3.0	5.0	1.0	1.2	1.5	2.0
	Long	2.5	4.0	6.0	8.0	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0	1.2	1.5	2.0	4.0
	Extra long	3.0	6.0	8.0	10.0	2.5	5.0	7.0	9.0	2.5	5.0	7.0	9.0	1.5	2.0	4.0	6.0
Small grain grown continuous or alternated with intertilled crops	Short	1.5	*2.0	*2.5	*3.0	1.3	*1.5	*1.8	2.3	1.3	*1.5	*1.8	2.3	1.0	*1.2	*1.5	1.8
	Medium	2.5	3.0	3.5	4.0	2.2	2.5	2.8	3.3	2.2	2.5	2.8	3.3	1.2	2.0	2.5	3.0
	Long	3.0	4.0	4.5	5.0	2.8	3.0	3.2	4.2	2.8	3.0	3.2	4.2	1.5	2.5	2.8	3.5
	Extra long	4.0	5.0	6.0	7.0	3.0	4.0	4.2	5.2	3.0	4.0	4.2	5.2	2.0	3.5	3.8	4.2
Small grain grown in rotation with intertilled crops, legumes, grasses	Short	0.8	*1.0	*1.2	*1.5	0.6	*0.8	*1.2	*1.5	0.6	0.8	*1.2	1.5	0.5	0.6	*0.7	0.8
	Medium	1.2	1.5	1.8	2.0	0.8	1.2	1.5	2.0	0.8	1.2	1.5	2.0	0.6	1.0	1.2	1.5
	Long	1.5	2.0	2.2	2.5	1.2	1.5	2.0	2.5	1.2	1.5	2.0	2.5	0.7	1.2	1.5	1.8
	Extra long	2.0	2.5	3.0	33.5	1.5	2.0	2.5	3.0	1.5	2.0	2.5	3.0	0.8	1.5	1.8	2.0
Small grain and meadow (including clover) rotation	Short	0.4	*0.5	*0.6	0.7	*0.2	*0.3	*0.4	0.5	0.2	0.3	0.4	0.5	0.1	*0.2	*0.3	0.4
	Medium	0.6	0.8	0.9	1.0	0.3	0.4	0.5	0.6	0.3	0.4	0.5	0.6	0.2	0.3	0.4	0.5
	Long	0.8	1.0	1.2	1.3	0.4	0.5	0.6	0.7	0.4	0.5	0.6	0.7	0.3	0.4	0.5	0.6
	Extra long	1.0	1.2	1.5	1.7	0.5	0.6	0.7	0.8	0.5	0.6	0.7	0.8	0.4	0.5	0.6	0.7
Legumes and grasses grown in rotation	Short	0.2	*0.2	*0.3	*0.4	*0.1	*0.1	*0.1	*0.2	0.1	0.1	*0.1	0.2	0.1	*0.1	*0.1	0.1
	Medium	0.2	0.3	0.4	0.5	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Long	0.2	0.4	0.5	0.6	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Extra long	0.2	0.5	0.6	0.7	0.1	0.1	0.2	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Meadow or pasture remaining 3 or more years	Short	0.1	*0.1	*0.2	0.2	0.0	*0.0	*0.0	*0.0	0.1	0.1	*0.1	0.1	0.0	*0.0	*0.0	0.0
	Medium	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Long	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Extra long	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0

Supporting Treatment		5				6				7				8			
System of Cropping or Land Use (a)	Average Length of Slope (c)	Crop or Rotation ✓ Strip Cropping ✓ Contour Cultivation				Crop or Rotation ✓ Strip Cropping ✓ contour cultivation ✓ lime & fertilizer				Crop or Rotation ✓ terracing ✓ contour cultivation				Crop or Rotation ✓ terracing ✓ contour cultivation ✓ lime & fertilizer			
		Slope Class A	B	C	D	Slope Class A	B	C	D	Slope Class A	B	C	D	Slope Class A	B	C	D
Planted annually to intertilled crops (3 or more years)	Short	1.0	*1.5	*2.0	3.0	*1.0	*1.0	*1.5	2.0	*1.0	*1.2	*1.5	3.0	*0.8	*1.0	*1.2	2.5
	Medium	1.5	2.0	2.5	3.5	1.5	1.5	2.0	2.5	1.0	1.2	1.5	3.0	0.8	1.0	1.2	2.5
	Long	2.0	2.5	3.0	6.0	2.0	2.0	2.5	5.0	1.0	1.2	1.5	3.0	0.8	1.0	1.2	2.5
	Extra long	4.0	8.0	10.0	16.0	3.5	4.0	6.0	12.0	1.0	1.2	1.5	3.0	0.8	1.0	1.2	2.5
Intertilled crops alternated with small grains (maximum of 2 years)	Short	*1.0	*1.3	*1.5	2.0	0.8	*0.8	*1.0	1.5	0.8	*1.0	*1.2	2.5	0.6	*0.8	*1.0	2.2
	Medium	1.0	1.5	2.0	2.5	1.0	1.0	1.5	2.0	0.8	1.0	1.2	2.5	0.6	0.8	1.0	2.2
	Long	1.5	2.0	2.5	3.0	1.3	1.3	2.0	2.5	0.8	1.0	1.2	2.5	0.6	0.8	1.0	2.2
	Extra long	2.0	4.0	6.0	8.0	1.5	2.0	3.0	4.0	0.8	1.0	1.2	2.5	0.6	0.8	1.0	2.2
Intertilled crops in rotation with small grains, legumes & grasses (b) (maximum of 2 years)	Short	0.8	*0.8	*1.0	1.5	*0.3	*0.4	*0.5	0.6	*0.4	*0.5	*0.6	1.0	*0.3	*0.4	*0.5	0.6
	Medium	1.0	1.0	1.5	2.0	0.3	0.4	0.5	0.6	0.4	0.5	0.6	1.0	0.3	0.4	0.5	0.6
	Long	1.3	1.3	2.0	2.5	0.3	0.4	0.5	0.6	0.4	0.5	0.6	1.0	0.3	0.4	0.5	0.6
	Extra long	1.5	4.0	5.0	6.0	0.5	1.3	1.5	2.0	0.4	0.5	0.6	1.0	0.3	0.4	0.5	0.6
Intertilled crops in rotation with small grains, legumes, grasses (maximum of 1 year)	Short	0.5	*0.6	*0.8	1.0	0.3	*0.4	*0.4	0.5	*0.3	*0.4	*0.5	*0.8	*0.3	*0.4	*0.4	*0.5
	Medium	0.6	0.8	1.0	1.5	0.3	0.4	0.4	0.5	0.3	0.4	0.5	0.8	0.3	0.4	0.4	0.5
	Long	0.8	1.0	1.5	2.0	0.3	0.4	0.5	0.8	0.3	0.4	0.5	0.8	0.3	0.4	0.4	0.5
	Extra long	1.0	1.5	3.0	5.0	0.5	0.8	1.0	3.0	0.3	0.4	0.5	0.8	0.3	0.4	0.4	0.5
Small grain grown continuous or alternated with intertilled crops	Short	1.0	*1.2	*1.5	1.8	*0.4	*0.5	*0.6	1.0	0.4	*0.4	*0.4	0.5	0.3	*0.3	*0.3	0.4
	Medium	1.2	2.0	2.5	3.0	0.4	0.5	0.6	1.0	0.4	0.4	0.4	0.5	0.3	0.3	0.3	0.4
	Long	1.5	3.0	3.5	4.2	0.4	0.5	0.6	1.0	0.4	0.4	0.4	0.5	0.3	0.3	0.3	0.4
	Extra long	2.0	4.0	4.5	5.0	0.4	0.5	0.6	1.0	0.4	0.4	0.4	0.5	0.3	0.3	0.3	0.4
Small grain grown in rotation with intertilled crops, legumes, grasses	Short	0.5	0.6	*0.7	0.8	*0.3	*0.3	*0.3	*0.4	*0.3	*0.3	*0.3	0.4	*0.2	*0.2	*0.2	0.3
	Medium	0.6	1.0	1.2	1.5	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.3
	Long	0.7	1.2	1.5	1.8	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.3
	Extra long	0.8	1.5	1.8	2.0	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.3
Small grain and meadow (including clover) rotation	Short	0.1	*0.2	*0.3	0.4	*0.1	*0.1	*0.1	0.1	*0.1	*0.2	*0.2	*0.2	*0.1	*0.1	*0.1	0.1
	Medium	0.2	0.3	0.4	0.5	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	Long	0.3	0.4	0.5	0.6	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	Extra long	0.4	0.5	0.6	0.7	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Legumes and grasses grown in rotation	Short	0.1	0.1	*0.1	0.1	*0.0	*0.0	*0.0	*0.0	*0.1	*0.1	*0.1	*0.1	*0.0	*0.0	*0.0	*0.0
	Medium	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Long	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Extra long	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Meadow or pasture remaining 3 or more years	Short	0.1	0.1	*0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Medium	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Long	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	Extra long	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0

* Values were obtained experimentally. Other values were calculated by extending experimentally-determined values

(a) Intertilled crops include corn, cotton, tobacco, sorghum, soybeans, etc.
Small grains include wheat, oats, barley, rye, etc.
Legumes and grasses include red clover, alsike clover, sweet clover, lespedeza, alfalfa, timothy, redtop, and various mixtures.
Meadows and pastures include the same crops listed under legumes and grasses, but remaining three or more years.

(b) If two years of intertilled crops are grown and a good cover crop is grown after the first intertilled crop, the annual soil loss for each of the two years will be the same as where but one intertilled crop is included in the rotation.

(c) Short -- less than 400 feet.
Medium-- 400 to 800 feet.
Long -- 800 to 1200 feet.
Extra long -- over 1200 feet.

placed at zero where soil is lost at a rate as high as 1 inch (143 tons per acre) per year.

TABLE 2.—*Efficiency rank and classes based on estimated time to erode suface 7 inches of soil*

Rank		Calculated life of surface 7 inches of soil (years)
Class	Percent	
Excellent	95 to 100	500 to 1,000.
Very good	85 to 94	150 to 499.
Good	75 to 84	75 to 149.
Fair	65 to 74	50 to 74.
Poor	55 to 64	25 to 49.
Very poor	Less than 55	Less than 25.

The application of such a procedure is illustrated in table 3 which shows the relative soil losses from different systems of cropping along with the relative efficiency rating expressed in percentage and rank. The fields on which these practices are applied represent different slope classes with respect to degree and length. It is apparent that the supplemental or supporting treatments needed to control erosion adequately on a given field are dependent upon many factors. Some of the most important of these factors are type of rotation or cropping system used, the length and percent of slope, need for lime and fertilizer, along with the erosion which has previously taken place. The degree of slope classification used is the same as that used in soil conservation surveys. The actual length of the slope classes may be adjusted for the different problem areas and can be used to take care of differences in erodibility of various soil types or groups that are well recognized. In like manner, these erosion factors will apply equally well to classes of land according to use capability as discussed in the Soil Conservation Survey Handbook (U. S. Department of Agriculture Miscellaneous Publication No. 352).

These erosion factors, listed under the different supporting treatments, are based on the assumption that

TABLE III EFFICIENCY OF SOIL CONSERVATION PRACTICES

(Based upon relative soil losses from various systems of cropping on slopes of variable lengths and degrees, supplemented by different supporting treatments)

System of Cropping or Land Use	Slope Degree Class	Slope Length Class	Supporting Treatments (1)	Ann. Soil Loss Tons per Acre	Estimated Time to erode surface 7 inches Years	Efficiency Rank	Efficiency in preventing erosion Percent
Cropped annually to intertilled crops	C	Long	1	160	6/	Very Poor	0
" " " " "	C	Long	4	80	12.5	Very Poor	18.3
Cropped annually to small grain	C	Long	1	45	22.2	Very Poor	47.9
" " " " "	C	Long	4	28	35.7	Poor	59.5
2 yrs. intertilled, 1 yr. small grain, 1 yr. meadow	C	Long	1	42	23.8	Very Poor	52.8
" " " " " " "	C	Long	4	19	52.6	Fair	66.1
" " " " " " "	C	Long	6	$3\frac{1}{4}$	307.7	Very Good	89.6
" " " " " " "	C	Long	8	3	333.3	Very Good	90.3
1 yr. intertilled, 1 yr. small grain, 2 yrs. meadow	C	Long	1	23	43.5	Poor	62.8
" " " " " " "	C	Long	4	9	111.1	Good	79.9
" " " " " " "	C	Long	6	2	500.0	Excellent	95.0
" " " " " " "	C	Long	8	1.5	666.6	Excellent	96.7
1 yr. intertilled, 1 yr. small grain, 2 yrs. meadow	C	Extra long	1	30	33.3	Poor	58.5
" " " " " " "	C	"	4	15	66.6	Fair	72.0
" " " " " " "	C	"	6	5	200.0	Very Good	86.5
" " " " " " "	C	"	8	1.5	666.6	Excellent	96.7
1 yr. intertilled, 1 yr. small grain, 2 yrs. meadow	C	Medium	1	16.5	60.6	Fair	69.5
" " " " " " "	C	Medium	4	7/	142.9	Good	84.2
" " " " " " "	C	Medium	6	2-	500.0	Excellent	95.0
" " " " " " "	C	Medium	8	1.5	666.6	Excellent	96.7
1 yr. intertilled, 1 yr. small grain, 2 yrs. meadow	B	Short	1	7/	142.9	Good	84.2
" " " " " " "	B	Short	4	4	250.0	Very Good	87.9
" " " " " " "	B	Short	6	2-	500.0	Excellent	95.0
" " " " " " "	B	Short	8	1.5	666.6	Excellent	96.7
Continuous meadow	C	Long	1	2	500	Excellent	95.0
" "	C	Long	2	0	1000/	Excellent	100.0

(1) Number refers to supporting practice or practices listed under corresponding number in Table I.

the supporting practices are initiated and carried out in conformity with specifications founded on the best information now available. It is obvious, of course, that improper terracing of land by the use of excessive vertical intervals, either excessive or inadequate grades, or improperly protected outlets, will not furnish the protection indicated in tables 1 and 3. Likewise, in the practice of strip cropping, all precautions must be taken to ensure minimum deviation from the contour, proper sequence and arrangement of crops on the strips, and the protection of all natural depressions with grassed waterways, if the protection indicated by the erosion factors is to be attained.

It is apparent from the data in table 3 that several supporting practices may provide the same degree of efficiency with respect to erosion control. This, therefore, makes it very necessary that the different possible conservation programs be considered from the standpoint of their relative effectiveness and economic application, so that the most appropriate control measures may be selected for given conditions.

Even though soil types differ markedly, yet they may be grouped and classified on the basis of their erodibility, their suitability for cultivation, and the supporting treatments or practices needed to protect them against erosion and fertility depletion. In the grouping of these soils and the prescription of suitable cropping systems and supporting conservation practices, due consideration must be given to the different slope classes with respect to degree and length as well as to the erosion which has already occurred. In the mapping procedure for soil conservation surveys, the slope classes A, B, C, and D represent significantly various ranges in degrees for different regions and States, as well as for soil types within regions. In like manner, the lengths in feet prescribed for the short, medium, long, and extra long slopes may vary widely from State to State and perhaps, in many instances, for different soil types and soil groups within the State.

The losses of plant food from cultivated land, through water erosion in the humid region, have been shown to be many times larger than are the losses incurred through the growing and removing of crops. Proper handling of the crop residues and manure contributes decidedly to the maintenance of the organic matter and nitrogen content of the soil. The very marked effect of straw or crop residues left as a mulch on the surface of the soil has been demonstrated and measured. This mulch increases the amount of water that filters into the soil; it lessens the losses of moisture through evaporation, and it reduces the amount of soil and plant food lost by erosion. With proper use of the crop residues while the cropping system is being carried out, the infiltration rate and amount will increase while erosion losses decrease.

On a few selected projects in Regions 3 and 5 a plan has been initiated for checking the calculated erosion factors listed in table 1. A number of farms on each project will be studied to ascertain the complete cropping history of each field on the farm dating from the time the field was first broken out of sod. This of course will limit the number of farms and fields to be studied, since it will be possible to secure adequate information on but a limited number of farms and fields on each project. For those farms and fields on which a complete cropping history can be secured, a very careful survey will be made whereby the depth of surface soil associated with slopes of varying classes of degree and length will be determined. In the beginning, observations will be confined to locations in each of the fields where the percent of slope is near constant.

Readings of soil depth will be initiated at the top of the ridge in the field and will be made at each 100-foot interval. Each field may furnish as many as 20 or more uniform slopes representing varying degrees, lengths, and different exposures, thus providing extensive data on each field. A record will also be secured of the predominant direction of cultivation and whether lime, manure, or commercial fertilizer has been used. After determining the amount of soil that has been lost by erosion for varying but known conditions, the average annual losses can be calculated.

In order to carry out this plan, it is obvious that we must be able to determine accurately the depth of the surface soil. This is somewhat complicated by the fact that, as soon as the depth of the original surface soil becomes less than the depth of soil turned by the plow, there is a mixing of the surface soil with the subsoil. For example, let us assume that a surface soil is 12 inches deep and plowed at a uniform depth of 6 inches, and that the management is such that there is an average soil loss by erosion of 1 inch in 5 years. This would mean that, at the end of 30 years, 50 percent of the surface soil would be gone. At the end of the thirty-first year the surface 6 inches of soil would consist of but 5.8 inches of the original surface and 0.2 inch of subsoil. After 60 years, 12 inches of soil would have eroded away, but there would yet remain 2.24 inches of surface soil since that removed through erosion consisted of 9.76 inches of the original surface and 2.24 inches of subsoil. After 100 years, although 20 inches of soil would have been lost, there would yet

remain approximately 0.6 inch of the original surface. Even after 150 years when 30 inches of soil would have been eroded away, consisting of 11.9 inches of the original surface and 18.1 inches of subsoil, 0.1 inch of the original surface soil would yet remain. It is recognized in making these calculations that the erosion process does not operate uniformly over a field to remove the surface inch without touching the layers beneath. An entire examination of the area in question will give the variation.

For the purpose of determining the accuracy with which the depth of the surface soil can be measured where considerable mixing with the subsoil has taken place, soil samples will be taken on two of the projects and examined with regard to the organic matter and exchangeable bases in the 7-inch layer. Preliminary trials were initiated this fall on the projects at Bethany, Mo., and Shenandoah, Iowa, to develop the technique and to test the possibilities of this approach toward determining the amount of surface soil that remains. The organic matter and the exchangeable bases will be compared with the quantities found in the surface, subsurface, and the subsoil where greater depth has prevented any mixing of the subsoil with the surface. A careful examination of the soil profile within each field will also be of great assistance in the original mapping of the depth of the surface soil.

Measurements of crop yields, as affected by soil depths, are being made on a few projects in Regions 3 and 5. The first crop to be used extensively is corn, since this crop is known to be a good indicator of fertility and is a major crop in these two regions. This crop also lends itself well to field sampling for yield determinations and this is an important factor. A few yield determinations already have been made in Iowa and Ohio. It was indicated by the personnel at Greenfield, Iowa, for example, that for 1938 a decrease of 2 inches in the soil depth resulted in a decrease of approximately 10 bushels per acre in the corn yield. From this it is not difficult to appreciate the importance of reducing or eliminating erosion while satisfactory yields are being secured so that these yields may be sustained. Past experiences in observations have indicated a wide variation in the effects of erosion on crop production. With the adoption of appropriate soil conservation practices, including soil amendments, some severely eroded lands representing certain soil types can be made to produce fairly high yields. However, for most soils this is not the case.

After it is established what the erosion factors are that give the rate of soil loss from land having varying slopes with respect to degree and length, and having different crops and supporting treatments or practices, it will be simple to predict the rate of soil removal and the corresponding decline in productivity. Because these erosion factors are based on what actually has happened to our soils in the past under varying conditions, and since we can expect little change in climate, we may expect erosion to occur under similar conditions in the future much as it has in the past.

By determining the effects of different soil depths with and without fertilizer or other soil amendments on crop yields, and by using the erosion factors for calculating the rate of soil loss, we have a very definite basis for calculating the benefits that may be derived throughout the lifetime of both the present and future generations when different cropping systems supported by various soil conservation practices are followed. These findings will prove very helpful in determining the cost and benefits to be expected from following different soil conservation practices and will assist in the planning for a farm, a project, or a district. These data will prove equally useful in evaluating the results to be expected on different farms and projects where soil conservation practices already have been planned or initiated.

WOODLAND CARIBOU IN MINNESOTA

(*Continued from p. 143*)

"The animals in captivity are fed mosses (of which many truckloads were stored for winter use), lichens, oatmeal, milk, and succulent plants. The seven animals consume almost a case of canned milk a day, and refuse to eat hay or other plant materials foreign to their natural habitat. They are given minerals regularly, and this undoubtedly accounts in part for their rapid growth. Their senses of taste and smell are extremely keen; it is, for instance, impossible to get the animals to take any brand of milk other than that first fed to which they have become accustomed. Even the addition of one tablespoonful of a different brand to a cup of milk is sufficient to cause refusal.

"The animals will be transferred to the larger pasture in the fall of 1939 for the breeding season. From this pasture they will be liberated, at almost 2 years of age, and it is hoped that they will join the other Minnesota caribou."

So much for Manweiler's interesting story. I am sure the reader will agree with me that the restocking experiment gives every indication of success.

However, the job is not finished. As has been shown in the case of most successful stocking experiments with either big game or game birds, it is advisable to obtain and liberate some more of the animals a year or two after the first attempt at stocking.

Erosion-Control Lessons From Old-World Experience

III. EROSION AT ITS WORST, AND A HUNDRED DEAD CITIES

By WALTER C. LOWDERMILK [1]

Entrance to Kalaat Samaan, the great sanctuary of St. Simon the Stylite. Some restoration is being done by the Department of Antiquities of Syria.

A SOIL conservationist finds in Syria many lessons which we of the United States may well take to heart. There mankind has lived and tilled vanishing lands for thousands of years. Decisive results of wasteful and inconsiderate use of land, as well as of the conservation of soil, may be found in the varied types of country of Syria. One may easily read the land use through the centuries writ large across the landscape, and see the fate of similar areas in the United States, unless a program of full conservation of land and waters is put into effect before it is too late.

Syria holds some of the grandest ruins to be found in the world. The ruins of Baalbek are without compare in grandeur and preservation to any that we have seen; they are some of the most magnificent ruins in the world today. There are huge stone blocks, 30 feet long, 14 feet high, and 14 feet wide, brought from the quarry about a mile away and laid down as foundation stones. Massive monolithic pillars of red granite had been quarried at Aswan, Egypt, and shipped 600 miles down the Nile River, and then across the Mediterranean to the North Syrian coast, unloaded and then rolled by human hands over a 5,000-foot pass across the Lebanon Mountains and down into the Bekaa and to Baalbek.

Hidden at the edge of the mysterious desert of Syria are the almost equally striking ruins of Palmyra, where Queen Zenobia so long defied legions of the Romans. On the North Syrian coast, Byblos, one of the oldest cities in the world, is gradually being brought out of its grave after being buried for centuries in debris. Its fascinating past is now being reconstructed through archaeological finds. Byblos was a town long before it was the Egyptian port from which the famous Cedars of Lebanon were shipped to Egypt for construction of dwellings and temples in the Nile Valley.

"Egbert, that young old man," 30,000 years old, has been covered with 40 feet of debris since he lived in a paleolithic cave home. Only last year his skeleton was discovered by Fathers Ewing, S. J., and Doherty, S. J., in the course of excavations of a paleolithic site near Beyrouth.

The long and significant past of this part of the world is beginning to be made known, but thus far, little attention has been given to the fate of the land which has been cleared and cultivated, terraced and wasted through the centuries, to supply the food and textiles which made possible the rise of man out of barbarism.

These great ruins in Syria reveal a past prosperity and opulence of populations under Egyptian, Greek, Roman, and Crusader domination. It would be impossible for these populations to thrive today on the surrounding stony sterile slopes. To a soil conservationist, the most striking ruins are those of about a hundred or more Dead Cities in North Syria, where soil erosion has done its worst and spread a ghastly destruction over a landscape of 1,150,000 acres of former productive lands.

These Dead Cities in their almost perfect state of preservation seem to have been more asleep than dead for 13 centuries. They have not been buried by erosion, but stand high on their rock foundations on the limestone hills, from which 3 to 6 feet of productive *terra rosa* soil have been washed away. This soil was the basis of a remarkable prosperity and opulence in ancient times for this region with its populous centers.

This erosion devastated area is in reality a huge graveyard in which cities of cut-stone stand like tombstones, weathered into a monotonous grayness like that of the exposed skeleton country rock of the rolling hills. Seldom does one find remnants of the red earth which formerly clothed the limestone hills; it is lodged in the narrow valley floors where it was saved

[1] Assistant chief, Soil Conservation Service, Washington, D. C.

from being swept out to the Orontes River by winter storms. The good earth is completely gone from the slopes except where walls of ruined buildings have held back small patches of soil. In these patches a few vines or olive trees stand as sorry remnants of a former profitable land use. Otherwise, the landscape is gray desolation, glaring in the summer heat and bleak in the winter cold. Sometimes one finds a yellow and gold desert varnish, or "patina," on the bared rock, giving a marvelous effect. It is fascinating to see toward evening the fairy spectacle of the ruins of Rouweiha silhouetted strange and mysterious against the evening sky. It appears as a modern city, devastated by war or fire. Many of the villas or churches had roofs and would be habitable today. The cut-stone was of such excellent quality and workmanship that the sculpture, moldings, inscriptions and escutcheons have resisted the weathering of centuries of abandonment.

These ruins are found in a region that is almost a desert today, lying within an area outlined by four great ancient cities, namely, Antioch on the west, Apamu (Kalaat el-Moudik) on the south, Chalcis (Quuniesrin) on the east, and Berea (Aleppo) on the northeast. Traced out on the map this region is a long rectangle about 20 miles wide and 90 miles long, or about 1,800 square miles, a huge area where erosion has done its worst.

The Dead Cities of North Syria reveal a period of history of which very little is thus far known. It was a local civilization but very advanced and rich, with a highly developed and distinctive Syrian art found nowhere else. This art was surprisingly delicate, full of freshness and originality. Father Mattern outlines the steps wherein one may follow a constant rise from the third to the seventh century without sign of decadence. But it was cut off in its vigor of life and development by the invasion of the Persians in 614 and the conquest of the Arabs in A. D. 630. These nomad invaders killed the inhabitants, blotted out their art and culture, and destroyed their cities, their vineyards and their olive orchards, and the traditions of their agriculture. Today, after thirteen centuries of neglect and patch cultivation to cereals by semi-nomadic descendants of the invaders, and of over-grazing by their goats, soil erosion has completed the destruction of the good earth with a thoroughness that has left this once fertile land a complete man-made desert, void of vegetation, water, and soil, except in rare pockets with scanty cover of crops and thorn bushes. The ruins of a highly developed architecture tell of the advanced culture of this region.

The first revelation of these Dead Cities of North Syria, after an undisturbed sleep of more than a thousand years, was made in 1861 by Viscount Melchoir de Vogue, who published his findings of his field studies in two volumes. In 1888 Fathers Jullien and Soulerin made a further study, which was reported in the "Review of Catholic Missions." In 1904 and 1909 two American expeditions were sent out from Princeton and added much information on the history and inscriptions of these Dead Cities, which has been published in three volumes. And in 1928, 1929, and 1931 Father Joseph Mattern, S. J., made a study of the ruins of churches in this area, but his scholarly interest lead his observations into a general account of these remarkable ruins. Few other expeditions have been made, due to the insecurity of traveling about in this desolate country. Another survey, made with Dr. Alford Carlton, President of the Aleppo American College, appears to be the first to study the lost agriculture surrounding the ruins.

The area of Jebel Riah and Kalaat Samaan, where most of the largest cities are found, were visited during one of the hottest periods of summer. From a point about halfway up the Kubbit Babutta, could be counted, lying to the north, at least 15 deserted and Dead Cities. The rolling foothills, once clad in vineyards and olive orchards, are gashed with deep ravines where remain, here and there, small pockets of soil which lodged as the red earth was being washed off the slopes. Today, only a few goats find meager herbage in this formerly productive area. A few scattered, sordid villages house a mere fraction of the numbers of a former progressive population. Usually, as at Kfar-Rouma, these villages are built on the site of former cities and the inhabitants have made use of the ruins as shelters or quarried rock from them to construct crude dwellings. There are places where the building blocks have been thrown pell-mell one upon the other as by an earthquake, but in other places stand buildings which appear to have been burned with fire only yesterday.

Particularly lending themselves to study, are the well preserved cities of Gerade, El Gami, Bara, and the ruins of Kalaat Samaan. In the center of the ruins of Gerade is a closely set group of buildings with stalls, small markets, and dwellings nearby. Around this center are a great number of villas grouped without reference to symmetry. The villas in the outskirts have many out-buildings, and are more spacious and richer than the houses in the interior of the city. The buildings of a villa are grouped around a court entered by a gate, often monumental and sometimes

surmounted by a tower. On the ground floor, the dwelling house usually has a long gallery supplied with elegant columns, on which open the doors and windows of apartments. Houses rarely opened on the streets. Beautiful motifs are sculptured in the rock lintels of doorways and windows. On each side of the doors we usually found two niches of different sizes. It is supposed the smaller one contained an olive oil lamp to light the gallery and the second and larger one sheltered the icon of a saint.

The town of Bara is described by the historians of the Crusaders in the Chronicles. It is evident that a civilization had been cut off in its flowering. Ruins of a great church at Bara indicate a striking elegance, and must represent, with the church of St. Simon at Kalaat Samaan, the culminating point of the development of Syrian architecture. Especially fine is a carved entablature, 30 by 32 inches and 7 feet 4 inches long in the basilica at Bara. The good taste and fineness of its decoration make one conclude that when it was built in 585 nothing predicted the decadence of this art or the oncoming catastrophe.

In this graveyard of cities are the ruins of the largest church built prior to the Twelfth century and may even claim to be the largest church yet built in the Near East. One is astonished at the view of the immense sanctuary of St. Simon. Its length is 325 feet and width 290 feet with a total area of 94,000 square feet. The rooms and galleries, baptistry and façade are almost intact. But the arched roof of the huge octagonal central room, around which these were grouped, had collapsed. Around all the ruined center were arches and columns within an enclosing outer wall with towers which must have given it the appearance of a fortress. This octagonal central room, 90 feet in diameter, appears to be unique in architecture. Each side is pierced by an arch supported by two monolithic columns. But it is of greatest interest because it housed the 65-foot pillar upon which St. Simon lived for 37 years until his death in A. D. 459. The immense height of the roof doubtless contributed to its fall, while other roofs remain intact.

After Simon's death, crowds from the four corners of the Christian world continued to come in great numbers. The resulting flow of money to this sanctuary led to the construction of this magnificent church enclosing his pillar. The great sanctuary, dedicated to St. Simon, is the synthesis of all that Syrian art has produced, and will remain an eloquent evidence of the creative power of Syrian architects as well as the faith of all this part of the Orient.

This church was not captured until 350 years after the Arab invasion in A. D. 630, when in A. D. 980 the Emir of Aleppo besieged the sanctuary, which had become a religious fortress. He captured and sacked it; some of the priests he killed, others he sold to slavery.

The extent and beauty of all these ruins show that this desolation of the land has not always existed. The present rocky hills, because of their having no soil, are victims of torrential run-offs each winter rainy season; but in summer there is no water except that accumulated in cisterns. The barren rocky hills are evidently far different from their former condition of beauty and productive fields in the valleys and fruitful olive orchards and vineyards on the slopes, which supported a flourishing civilization.

Contemplation of these ruins raises a number of questions. How can one account for ruins of luxurious cities with buildings constructed of choice material in a manner to endure the ages and in a region which today is denuded, poor, meagerly supporting a few hundred miserable families? How can one explain the former populous centers and prosperity? Whence came such wealth which permitted them to satisfy their artistic tastes and a refined luxury in homes, public buildings, and churches?

This region was once covered with extensive forests. Present day remnants indicate that the principal species were of oak, pine, cypress, and cedar in the higher elevations. Evidence of the forest is found in the architecture. Had not an abundant supply of timber been available the architects would have developed a different type of construction, as they did in the Hauran and elsewhere as we saw in Um Jemal, where timber was not readily accessible. These villas and grand rooms and churches required sturdy timbers of wood as called for by notches in the walls at El Gami, Bara, and other ruins. The ceilings were generally of wood. Much timber was also required for the galleries and furniture and fuel for heating the villas and the water for the baths. Large timbers must have been needed to raise the enormous blocks of stone used in construction, and to build the forms on which were laid the heavy stone arches. Thus for four centuries at least there must have been a sufficient supply of timber in the near vicinity, and of an amount to arouse no anxiety for the future. The removal of the forest doubtless took place as a slow deforestation of the mountains and cultivation of cleared areas, and later the planting of vineyards and olive orchards on a vast scale.

Father Mattern holds that this area was definitely an intensive agricultural country. The location of the

Section of the ancient Roman road from Aleppo to Antioch and passes through the northern portion of the Dead City area. The soil has been washed away from the road, leaving it standing in relief.

houses indicates that the inhabitants did not possess great territorial properties as did the Romans in Campania, Italy, Sicily, and North Africa. These Dead Cities, even in the more isolated regions were much too close together to allow for anything but intensive exploitation. Furthermore, the wealth could not have come from great herds, for the population required that the use of land be much more intensive than pasturage. These populous cities were doubtless supplied from the products of the immediate countrysides because there are no fertile areas in nearby plains accessible by roads to supply them with produce. They were self-sustaining and derived their wealth from exports of agricultural products.

Many olive oil and wine presses are to be found in the ruins, especially at Bara. There is what was obviously a large olive oil factory, with ruins of numerous presses and great bins. Mattern reports countless presses in his detailed examination of a large number of ruins. These presses are found everywhere on the ground floors of villas or in the neighboring houses in towns or in the cities. They were sometimes cut in the rock and most often were accompanied by reservoir cisterns such as can be noted at Bara and Gerade. Presses and cisterns were of many sizes. Often one finds them grouped, indicating that harvesting of a considerable area was carried out in common.

The olive and the vine doubtless provided the wealth and prosperity of the country. Wine and oil were two products which could easily be exported at good prices to Italy and the great cities of the west. The hill of Testaccio on the borders of the Tiber in Italy is entirely formed by the debris of the huge earthen jars of wine and oil which came by boat from the area of these Dead Cities, and were here transferred to smaller jars for sale. The great jars, characteristic of North Syria, were too numerous for further use in Italy. It does not seem that their return was considered feasible. And so important was the import of wine and oil that the broken jars when cast out during centuries of time had built up the unique hill of Testaccio. This remarkable hill gives some clue to the great production of this area in exportable wines and oil. The producers were enriched and the auxiliary industries shared in the prosperity of the land.

This region, before erosion transformed it into a desert, was well supplied with water. One finds stone spring houses beside springs which ceased to exist when the soil was removed by erosion. In some instances there appears to have been perennial water in the now dry streambeds. Moreover, these people were supplied with numerous and large cisterns, both in fields and towns. Each home was supplied with one or two cisterns within the walls to provide water supply during the rainless summer season. Many cisterns can be noted along paths and among the ruins. They are excavated out of the rock in the form of immense jars to protect them from caving in. The quarried stone was then used in the construction of buildings.

Aerial view of Hirbet Haas, southwest of Bara. Note the soil poverty of the area, and the marks of the old field boundary walls. The walls of the buildings are in a good state of repair. (Photo courtesy of Father J. Mattern.)

The evidence is that soil erosion was sufficient to destroy this area which supported a hundred or more prosperous cities of North Syria until 12 centuries ago. In a number of instances measurements have been made of the depth of soil which has been removed. For example, at the church of Mousabbak, the first steps begin at 4½ feet above the present ground or rock level. These lower blocks are foundation and undressed stones whereas 4½ feet higher the steps and stone work are dressed and polished. These foundation stones were formerly covered and have become bared since the ancient soil was washed away. Also, it is impossible to explain the use of certain olive oil presses except on the assumption that the soil was then 6½ feet deep over the present rock surface. This depth of soil must have been washed away. Soil wash is still continuing where any soil is left. Butler of the Princeton Expedition reports having observed the process during a winter storm. In some places caps of red soil still remain on the tops of mountains as at Djebel Sheikh Berekat or on level areas, and from these flow red streams of soil during the rainy season, giving a last example of what has gone on for centuries in North Syria.

It is not necessary to invoke adverse climatic changes to explain this desolation and desiccation of this ancient prosperous region. Wherever the walls of ruins prevented the soil from being washed away, vines, olive trees and shrubs are growing today. Bara is still noted for its vines, which are limited now to the few places where patches of soil are still found. Two miles south of Sunkhar a grove of trees appears as an oasis in a dreary gray land surrounding a high tower among the ruins, where a large pocket of soil has been held back on a flat protected by walls. The town is in ruins and the lofty tower rises in splendid isolation above the trees which occupy the only remaining soil in this region.

As in North China, North Africa, Trans-Jordan and elsewhere, soil erosion is clearly the principal agent in destroying the land and in undermining the civilization and culture which was dependent upon it. The early inhabitants found primeval forests here. Then began moderate clearing, deforestation and cultivation of slopes. Ancient cultivation up through the Roman period was intelligent and demonstrated an understanding on the part of the inhabitants of the conservation of soils and rain waters by terraces and check dams. At this time the region was highly prosperous, populous, and flourishing. But in A. D.

630 the Arab invasion swept away progress in agriculture. The vineyards and olive trees were destroyed, and the land was put under patch cultivation to grain crops and heavily grazed. After the destruction and dispersal of the former population, neglect of the land, especially under the Turkish domination of 400 years, brought on erosion of the soil. The hordes of invaders from the east and south, in their rapid passage, had neither the time nor the means to demolish the huge stone blocks comprising the great buildings. But by fire and the ax they destroyed the remaining forests as well as the plantations of olives and vines.

These nomad invaders have always shown themselves to be enemies of trees; their descendants have remained true to this hate, whether it be in North Africa, Syria or Trans-Jordan. The Arab nomads are spoken of as "sons of the desert", but in view of the deserts they and their goats have created, it would be more fitting to speak of them as "fathers of the desert." They pitch their black, batlike tents amidst ruins of the magnificence of the past and allow the terraces to break down and the soils to wash away. They permit their goats to destroy and trample out the former measures for conservation of soil and water. They practice a Neolithic type of agriculture; for they are always on the move and have little interest or inclination to protect the diminishing soils. The nomad invaders and their goats worked hand in hand with erosion to destroy the fertility of the lands.

These hundred or more Dead Cities are dead forever because their soils are gone beyond any hope of reclamation. The cities could be made habitable again with no great amount of work. The buildings would be more sumptuous than those in any of the Twentieth century towns and villages in this or surrounding areas. But when this good earth was sinned against it would not produce; it carries the curse of despoliation which continues to curse this region. Man and erosion have devastated this area for a geologic age. Here the "unpardonable sin" of land use has been committed.

Man-induced erosion of the soil has in this region of about 1,150,000 acres done its worst; it has swept 3 to 6 feet of soil from the hill lands, baring the limestone skeleton of the country. It has removed the support of the former prosperous population which found wealth and leisure enough to delight in and develop an art and architecture of unusual vigor and beauty. The people and the civilization vanished leaving the Dead Cities of North Syria as tombstones above a stark and barren landscape. They tell the tragic story of the terrible curse upon the land and future inhabitants when soil erosion is permitted to despoil the soil and water resources.

Literature

(1) Butler, H. C., American Archaeological Expedition to Syria in 1899–1900. Part II, Architecture and other Arts, New York, 1904.

(2) ——— Syria, Publications of the Princeton University Archaeological Expeditions to Syria in 1904–05 and 1909. Division II, Architecture, Section B, Northern Syria.

(3) ——— Early Churches in Syria, ed. by E. Baldwin Smith, Princeton, 1929.

(4) Mattern, S. J., Father J., A Travers les Villes Mortes de Haute Syrie, 1933, Imprimerie Catholique, Beyrouth.

(5) de Vogue, Syrie centrale, Architecture civile et religieuse du III^e au VII^e siecle. 2 in-4°. Paris, 1865–77.

FOR REFERENCE

(Continued from inside back cover)

Orchard Soil Management: Some Effects of Different Practices on the Soil. Bulletin No. 373. Agricultural Experiment Station, State College, Pa. February 1939.

A Preliminary Economic Appraisal of the Soil Conservation Program in the Beaver Run Watershed, Westmoreland County, Pennsylvania. Agricultural Experiment Station, State College, Pa., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. September 1938. mm.

Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area: Economics of Agricultural Land Use Adjustments, II. Research Bulletin 241. Agricultural Experiment Station, Ames, Iowa, in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. October 1938.

Some Economic and Social Aspects of Irrigation in Montana. Bulletin No. 354. Agricultural Experiment Station, Bozeman, Mont. January 1938.

The Tax System of Nebraska with Special Reference to Its Relation to Agriculture. Research Bulletin No. 105. Agricultural Experiment Station, Lincoln, Nebr. October 1938.

Vegetative Composition, Density, Grazing Capacity and Grazing Land Values in the Red Desert Area. Bulletin No. 229. Agricultural Experiment Station, Laramie, Wyo. July 1938.

Yield Tests and Land Valuation. Research Bulletin No. 252. Agricultural Experiment Station, Ames, Iowa. March 1939.

Miscellaneous

Analysis of Interregional Competition in Agriculture. Bureau of Agricultural Economics, U. S. Department of Agriculture. April 1939. mm.

Farming Hazards in the Drought Area. Research Monograph XVI. Works Progress Administration. 1938.

Sorting and Sampling Farms for Soil Conservation Research. Bureau of Agricultural Economics, U. S. Department of Agriculture. October 1939. mm.

A Study of Farming in the Gilmore Creek Soil Conservation Demonstration Area, Winona County, Minnesota. (Some Implications of the Recommended Soil and Water Conservation Program.) Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture, in cooperation with Minnesota Agricultural Experiment Station. June 1939. mm.

FACTORS AFFECTING RUN-OFF FORECASTS BASED ON SNOW SURVEYS

(*Continued from p. 151*)

spring as determined by tests of the soil, ground-water levels and winter stream flow. To the same end, the possible significance of early fall and late spring rainfall is being investigated.

As a specific instance where the water supply forecasts have been of great value to irrigationists the case of Utah in 1934 is cited. Utah was one of the States having a State-wide snow survey program prior to 1935, and was thus prepared for the 1934 drought. The winter was extremely moderate. It was early indicated that there would be a water shortage, the extent of which was not known until the snow surveys were made on the principal watersheds of the State. During the midwinter snow surveys a marked deficiency of snow cover, a dry soil under the snow, and winter melting were found and were interpreted as pointing toward a serious water shortage. The more complete annual surveys made in April supported the earlier findings and emphasized the pending water shortage. This information was immediately publicized and put into the hands of irrigators, power companies, municipalities, and other water users. At first, many water users refused to recognize the seriousness of the situation. There followed a meeting of representative water users called by the Governor of the State to consider the situation. The gathering concluded that an emergency existed and the Governor, on the strength of this conviction, wired the Federal Government at Washington for assistance in combating the drought. An initial sum of $600,000 was granted the State and later the sum was augmented to an approximate total of about $1,400,000. At the same time a water conservation program was instituted. This comprised two lines of attack: First, the education of water users in methods of conservation and better use of water; and second, a survey of possibilities for developing supplementary water supplies that might be carried out through use of Federal funds. Both parts of the program were successful. Farmers were contacted in every irrigated community in the State and persuaded to put into effect prescribed water conservation measures. A water development program was executed with Federal funds which yielded approximately 400,000 acre-feet of water.

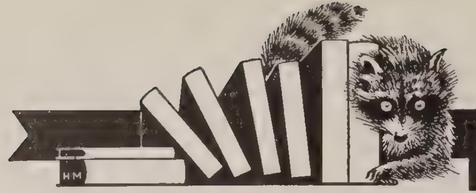
Estimates made at the end of the season indicated that a saving in crops alone of over $5,000,000 had been effected. In addition a tremendous saving resulted from feeding and removing range stock that otherwise would have succumbed for lack of pasture and water. Also, the water power companies were enabled by the advanced information to provide supplemental power in advance of its need. Furthermore, the program was followed closely by cities and towns, to the end that great inconvenience was avoided.

Besides these material savings there was also a spiritual benefit that is difficult to appraise. Farmers were saved the labor and cost of seed, which if spent, would have yielded them nothing. Water commissioners were given courage to distribute water with justice to all and favors to none. Maximum use of the water was made without causing jealousy and animosity among water users.

COOPERATIVE FARM FORESTRY

(*Continued from p. 137*)

research, and operations on the land. In all probability, the path will not always be smooth; obstacles and difficulties that cannot even be foreseen at this point will doubtless arise. But if the various State and Federal agencies work closely together, if they constantly improve their efforts through research and experience, and especially if they heed the wise counsel of cooperating farmers, the farm forestry work may prove eventually to be one of our most important avenues to better use of American land.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

McMICHAEL'S APPRAISING MANUAL, 2d EDITION. By Stanley L. McMichael. New York. 1939.

Twenty new chapters have been added to this manual. In its first-edition form the volume has been widely used, for some years, by land and property appraisers. The new enlarged edition is reviewed here chiefly for the benefit of the land acquisition division personnel of the Service whose work in the field involves appraisal of land for soil conservation purposes. The book should be useful also to land owners, and for that matter to anyone who owns or contemplates owning anything in the way of real property.

New viewpoints on the appraising procedure and new standards of value are pointed out in the first chapter; and "value, its meaning and how to measure it" is treated in five succeeding chapters with special emphasis on management as a factor in estimating value, population growth or decline as influencing land or real estate values, shifting business and changing values, and the proper approach to the valuation estimate. Depreciation is then discussed at length, and the causes of economic, functional and physical depreciation are listed in convenient form, with numerous examples, so that the appraiser may have at hand a complete and handy reminder of all phases of valuation processes.

The "annuity approach" to calculating the present worth of estimated future benefits is set forth at some length in a chapter headed "Interest Tables and Their Uses" and a series of tables is included for rapid calculation appraising. Chapters 11 to 17 are devoted to the functions of the appraiser and directions for appraising specific properties—office buildings, apartment houses, warehouse properties, harbor and water-front holdings and gasoline stations. Then follows a special treatment of the appraising of agricultural lands:

Soil quality is given as of first importance as an appraisal asset in appraising agricultural land. The soil rating chart evolved by the staff of the College of Agriculture of the University of California is shown as a sample "measuring rod" to be used in distinguishing the nature and value of different soils encountered on a farm; and Jennings' informative rating chart for listing and comparing soil factors is included to point out soil profile, texture, surface relief, internal drainage, and alkali percentage as important points to be considered. Topography, water supply, pest control, fertilization, improvements, management and operation and cost records, county averages of valuation, and location of the land are discussed separately as features to be given careful consideration in farm appraisals. The complete statement of an actual farm appraisal is given with this chapter.

Another chapter that no doubt will be useful to land acquisition workers of the Service is that dealing with appraising for condemnation. This is pointed out as an extremely complicated branch of the appraisal activity, and the author has included all necessary information regarding factors to be considered for this type of appraisal.

Governmental activities that influence property valuation at the present time are discussed briefly in chapter 23. The remainder of the volume is devoted more or less to procedures for specialized appraisals—residential property, corner lots, triangular lots, odd-shaped properties, blighted areas, tree values, etc.

The book proper contains many charts, diagrams, tables and sample appraisals to be used as time and labor savers by appraisers, while in the appendix is to be found a great variety of information that serves as supplementary help.

DIRECTIONS FOR COLORING LANTERN SLIDES, TRANSPARENCIES AND PHOTOGRAPHS.

By Bernard L. Simmons. Mimeographed publication, Section of Information, Soil Conservation Service, Washington, D. C. May 1939.

This publication is designed especially as an aid to visual information artists throughout the Service whose duties include the preparation of colored photographic material. Lantern slide coloring is treated first, with directions for choosing, preparing and applying and blending the color. A sample slide is shown, with numbered sections, and by means of this device the artist is instructed in applying and blending color to trees, sky and clouds, fields in the foreground and hills in the background.

The correct way to color photographic transparencies with oil colors, using a light table, is carefully described as to type of color and thinning medium, applicators and light table, preparing the slick-surface transparency, and the actual work of applying the color. Brief directions are given for coloring photographs on glossy surface and on full-matte and semi-matte surfaces. Some helpful general suggestions are included at the end of the publication to help the colorist in refining his effects.

Mr. Simmons, the author, is in charge of the illustrations unit in the division of information, Soil Conservation Service, Washington, D. C.

GENERAL CARTOGRAPHY. By Erwin Raisz. New York. 1939.

This book is called to the attention of the many people in the Service who are interested either directly or indirectly in the art of map-making. The volume is divided into two parts, General Cartography and Special Maps. Under the first title the reader finds a rather extensive history of map-making—four chapters of history to be exact; and, following this, the specialized subjects relating to cartography are presented with great care for detail. The first of these subjects, scales and projections, leads into a discussion of the representation of the earth's pattern on maps and the composition and drafting of maps. Lettering is treated, also, as a special subject.

The second part of the book covers official and professional maps; diagrams, statistical maps, and cartograms; science maps and diagrams; globes, models, field sketching, and cataloging. One very unusual chapter treats of engraving and related subjects, and there are about 200 illustrations distributed throughout which contribute greatly to the value of the work to those directly concerned with the art of making and reproducing maps.

The new Yearbook of Agriculture (1939) is now available through the Office of the Superintendent of Documents. The large volume, entitled "Food and Life," deals with the nutrition of animals and human beings.

U. S. GOVERNMENT PRINTING OFFICE: 1939

Economic Studies Relating to Soil Conservation Featured in New List

For REFERENCE Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information, U. S. Department of Agriculture

Conservation Farming Practices and Flood Control. Miscellaneous Publication No. 253. Soil Conservation Service. October 1936.

An Economic Study of Cattle Business on a Southwestern Semi-desert Range. Circular No. 448. Forest Service. December 1937.

The Farmer Looks Ahead—Four Yardsticks for Measuring Future Farm Production: Domestic Consumption, Foreign Demand, Soil Conservation, Farm Income. Farmers' Bulletin No. 1774. Bureau of Agricultural Economics. May 1937.

Federal Seed-Loan Financing and Its Relation to Agricultural Rehabilitation and Land Use. Technical Bulletin No. 539. Bureau of Agricultural Economics. October 1936.

The Nation and the Soil—The Remedies: Economic Stabilization. Yearbook Separate No. 1622, Reprint from pages 289–295, 1938 Yearbook of Agriculture. 1939.

Soil Erosion and Stream Flow on Range and Forest Lands of the Upper Rio Grande Watershed in Relation to Land Resources and Human Welfare. Technical Bulletin No. 567. Forest Service. May 1937.

Agricultural Experiment Stations

Certain Economic Aspects of Agriculture in the Jackson County Soil-Conservation Area. Bulletin No. 291. Agricultural Experiment Station, Morgantown, W. Va., in cooperation with the Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. July 1939.

Classification and Agricultural Value of New York Soils. Bulletin 619. Cornell University Agricultural Experiment Station, Ithaca, N. Y. January 1935.

Economic Benefits of Irrigation From the Kingsley (Keystone) Reservoir. Bulletin No. 311. Agricultural Experiment Station, Lincoln, Nebr. October 1937.

Economic Phases of Erosion Control in Southern Iowa and Northern Missouri. Bulletin No. 333. Agricultural Experiment Station, Ames, Iowa. June 1935.

The Economic Relation of Tractors to Farm Organization in the Grain Farming Areas in Eastern Washington. Bulletin No. 310. Agricultural Experiment Station, Pullman, Wash. April 1935.

An Economic Study of Farming in the Crooked Creek Area, Indiana and Armstrong Counties, Pennsylvania. Bulletin No. 369. Agricultural Experiment Station, State College, Pa., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. June 1938.

An Economic Study of Land Utilization in Wyoming County, New York. Bulletin No. 707. Cornell University Agricultural Experiment Station, Ithaca, N. Y. November 1938.

Economics of Agricultural Land Use Adjustments. I. Methodology in Soil Conservation and Agricultural Adjustment Research. Research Bulletin No. 209. Agricultural Experiment Station, Ames, Iowa. March 1937.

The Economy of Soil Nitrogen Under Semiarid Conditions. Experiment Station Bulletin No. 215. Agricultural Experiment Station, Stillwater, Okla. December 1933.

The Effect of Land Use and Management on Erosion. Bulletin No. 585. Agricultural Experiment Station, Wooster, Ohio. July 1937.

Factors Affecting the Economic Self-Sufficiency of the Middle Rio Grande Conservancy District. Bulletin No. 247. Agricultural Experiment Station, State College, N. M. April 1937.

Factors Affecting Farm Land Values in Missouri (From an Appraisal Viewpoint). Research Bulletin No. 229. Agricultural Experiment Station, Columbia, Mo. September 1935.

Factors for Profitable Farming on Limestone Hill Land of the Eden Formation in Kentucky. Bulletin No. 384. Agricultural Experiment Station, Lexington, Ky. August 1938.

Family Incomes and Land Utilization in Knox County. Bulletin No. 375. Agricultural Experiment Station, Lexington, Ky. November 1937.

Family Living on Poorer and Better Soil. Bulletin No. 320. Agricultural Experiment Station, State College, Miss. September 1937.

Farm Adjustments in Saluda County, South Carolina. Bulletin No. 315. Agricultural Experiment Station, Clemson, S. C., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. June 1938.

Farm Business Summary, Farms Cooperating With the Soil Conservation Service, Franklin County, North Carolina, 1937. Agricultural Experiment Station, Raleigh, N. C., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Summary, Farms Not Under Agreement With the Soil Conservation Service, Franklin County, North Carolina, 1937. Agricultural Experiment Station, Raleigh, N. C., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Survey on 123 Farms Located in Arrowsmith and Dawson Townships, McLean County, Illinois, 1937. Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Survey on 43 Farms Located in Buckeye and Dakota Townships, Stephenson County, Illinois, 1937. Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Survey on 99 Farms Located in East Marion and West Marion Townships, Williamson County, Illinois, 1937. Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Survey on 38 Farms Located in Perryton Township, Mercer County, Illinois, 1937. Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

Farm Business Survey on 59 Farms Located in Pin Oak Township, Madison County, Illinois, 1937. Agricultural Experiment Station, Urbana, Ill., in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm.

The Farmer Looks at Soil Conservation in Southern Iowa. Bulletin No. 381. Agricultural Experiment Station, Ames, Iowa, in cooperation with Soil Conservation Service, U. S. Department of Agriculture. June 1939.

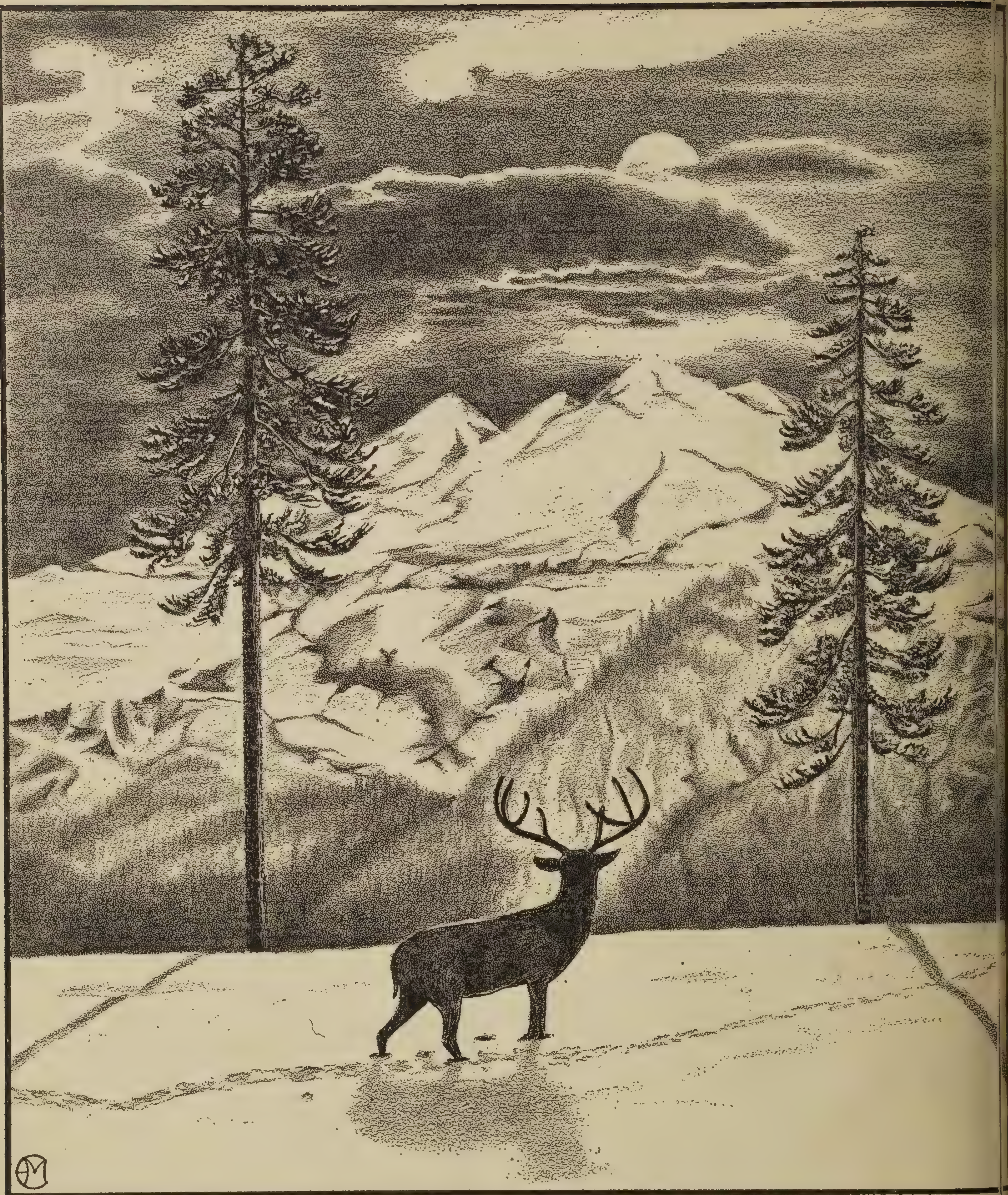
Farming Possibilities in Horry County, South Carolina. Bulletin 318. Agricultural Experiment Station, Clemson, S. C., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. May 1939.

Farm Practices and Their Effects on Farm Earnings. Bulletin No. 444. Agricultural Experiment Station, Urbana, Ill. August 1938.

Influence of Rainfall, Cropping, and Cultural Methods on Soil and Water Losses. Bulletin No. 380. Agricultural Experiment Station, Fayetteville, Ark. June 1939.

Influence of Tenancy on Types of Farming and Agricultural Income by Soil Types, Minidoka Irrigation Project. Agricultural Experiment Station, Moscow, Idaho. Bulletin No. 222. June 1937.

(Continued on page 162)



This fine buck will need food during the winter months ahead. Many ranches of the West adjust their range conservation programs to provide for wildlife forced to lower altitudes by deep snow in the mountains

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

"The engineering work of the Service is characterized by the diversity and magnitude of projects and problems encountered," notes T. B. Chambers (page 165). "All activities must be fitted into a workable program that harmonizes with the ultimate land-use objectives of the Department of Agriculture."

That the rates of run-off resulting from similar rains vary with the seasons of the year, that is to say, with conditions of cover and tillage and soil moisture, is clearly indicated by the preliminary results of studies on demonstration projects. (See the article by Krimgold, Weber, and Minshall, beginning on page 186.)

Dr. W. C. Lowdermilk, in the fourth of his articles on "Erosion-Control Lessons From Old-World Experience," discusses the fruits of 700 years of experience in England in dealing with surplus and flood waters. His article starts on page 191.

At special invitation of this magazine, Dr. Paul B. Sears appears as guest book reviewer, with an illuminative appraisal of Dr. Bennett's new book, "Soil Conservation" (page 196).

JANUARY

1940

This Issue Devoted to Engineering Aspects of Soil Conservation

Contents

Front and back covers by Adrian Clem

WELLINGTON BRINK
EDITOR

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. Soil Conservation seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION ENGINEERING

By T. B. CHAMBERS [1]

THE physical land-use adjustment programs—erosion control, irrigation and drainage, the farm phase of flood control, the water-facilities program, submarginal-land purchase and development, and farm forestry—are now a function of the Soil Conservation Service. The amalgamation of these varied activities has resulted in an enlargement or broadening of policies, and their administration has necessitated adjustments in the original Soil Conservation Service organization. Although all divisions of the Service have felt the effect in one way or another, the engineering work probably has increased more in variety and magnitude than any other branch. The primary purpose of the articles assembled in this issue of SOIL CONSERVATION, as in the January 1939 issue, is to point out in some detail the place, kind, and extent of engineering performed by the Soil Conservation Service, together with current problems, procedures, and progress.

The nature of the various programs now administered by the Service diverts automatically a large share of the field responsibilities to the engineers of the Service. The development of purchased submarginal lands involves a variety of engineering activities. Areas designated for grazing require extensive fencing and livestock watering developments. Roads, impounding dams, numerous types of buildings, as well as other structural improvements, are required on areas to be used for recreational and wildlife purposes. The transfer of the departmental drainage and irrigation activities, two well-established fields of engineering work, places additional responsibilities on the Service. The productivity of large agricultural areas is dependent upon proper design, installation, and maintenance of suitable drainage and irrigation systems.

The basic purpose of the Water Facilities Act is to promote proper land use by providing numerous engineering installations to conserve and utilize water for stock or domestic use or for application to farm gardens, crop or hay lands, range or pasture lands, or to other lands used for agricultural purposes. The hydrologic, sedimentation, and economic investigations in connection with the flood-control program present distinct engineering problems as well as the structural aspects. All these engineering activities must be executed in addition to the mechanical, structural, and other supplemental engineering measures required for an effective erosion-control program.

The engineering work of the Service is characterized by the diversity and magnitude of projects and problems encountered. In the broadest sense they are predominately agricultural engineering. To supplement modest farm incomes, natural resources must be fully utilized and other practical agricultural requirements must be met. It is not a spectacular type of work; it involves rather a variety of comparatively small works scattered over large areas, the majority of which must be applied on a farm-unit basis. Yet, to be well done it requires the highest type of engineering ability. The variety and multiplicity of units, as well as the development and standardization of techniques and methods to meet agricultural conditions, requires as much engineering resourcefulness as structural accomplishments noted for their technical complexity or grandeur. Furthermore, all activities must be fitted into a workable program that harmonizes with the ultimate land-use objectives of the Department of Agriculture.

As in all new engineering fields, there is a woeful lack of experience, precedent, and fundamental research information. Upon analysis, most problems require scientific data and tested practice for their solution. The same fundamentals of hydraulics, mathematics, physics, mechanics, etc., that are used in established engineering fields are necessary, but they require new applications. Agricultural engineers soon discovered that the prevention of erosion, the drainage of flat lands, or the irrigation of arid farms was not simply a matter of building structures or designing hydraulic channels. Of greater importance is the drafting of a comprehensive procedure to harmonize with proper land use, cropping requirements, variation in soil types, and farming practices or organization. Due to their training or natural inclinations, many engineers tend to limit their vision of specific problems to the immediate details of a ponderable mass of hydraulic or methematical formulations and to overlook the ultimate objective or proper application of engineering in agriculture. The adoption of a comprehensive view, without sacrificing necessary fundamentals, is essential for success. A distinct field of soil-conservation engineering unfolds therefrom.

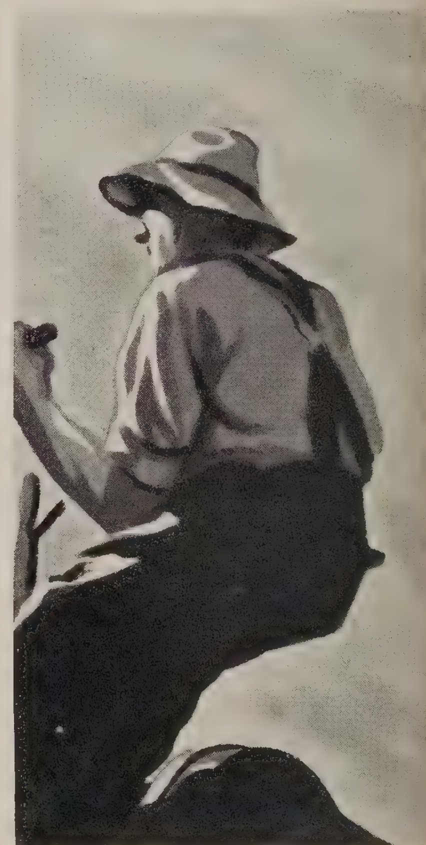
[1] Chief, engineering division, Soil Conservation Service, Washington, D. C.

Original field condition

TERRACE CONSTRUCTION IN SIX ROUNDS

Third round

End of first round



Fifth round

Completed terrace---sixth round

Adequate size was obtained in six rounds on this Louisiana terrace. Dirt was moved from the upper side only. This method is of particular advantage on the steeper slopes.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 7 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON JAN. • 1940

AGRICULTURAL ENGINEERING AND FARM PLANNING

By HOWARD MATSON [1]

IN planning farms for soil and water conservation the final plan represents a combination of recommendations involving the application of practices based on the sciences of soils, engineering, agronomy, and, in many instances, forestry and biology.

Since the knowledge and experience of each individual technician in the planning group constitutes an important contribution to the final plan dealing with each separate farm problem in relation to every other problem, it naturally follows that the engineer, as well as other technicians, must integrate his planning activities with those of other members of the group. The development of a practical farm plan for soil and water conservation that will treat each acre in accordance with its needs and adaptabilities, can be realized only when the various separate technical aspects dovetail or fit into the over-all plan.

In Region 4 experience has indicated that this can best be accomplished by "group" planning as distinguished from "one-man" planning. In soil conservation districts, the planning group usually consists of a farm planner and an agricultural enginner. Another technician may be added to the group where a major forestry, wildlife, or agronomic problem is involved. By training and experience, the farm planner ordinarily is able to give due consideration to the economic, agronomic, farm-management, forestry, and wildlife factors in developing an adequate land-use plan. It is the responsibility of the agricultural engineer to assist in coordinating needed engineering treatments and developments with other phases of the program and to make such surveys as may be necessary to ensure the adequacy of the engineering measures proposed.

Before the planning group goes to a farm to develop a plan, the engineer should make a careful study of the aerial photographs and physical land surveys covering the farm in question and all farms surrounding it. By this study he can determine the drainage pattern of the area, and in most instances he will be able to decide whether the farm may be considered alone or should be planned in conjunction with one or more of the surrounding farms. When farms are interrelated by drainage problems, the engineering measures and developments may be most effectively and economically applied if planned on a watershed- or drainage-pattern basis rather than by individual farm units. The engineer will find it helpful to prepare a drainage-pattern sketch for use in the field.

A thorough understanding of the agricultural engineering considerations involved, and their coordination with other phases of the program in the development of a farm plan, may be obtained through a study of the representative plan shown with this article. George Stewart lives in a recently organized soil-conservation district and, when he applied to the district supervisors for assistance, his farm was recommended to the district conservationist for planning. When the engineer examined the aerial photographs and physical land surveys covering the George Stewart farm to determine the drainage pattern, he found that Field 1 on the Stewart farm was affected by drainage from cultivated fields on the Ralph Blake and Fred Morris farms above, and that some of the terraces on Field 1 were emptying into a gully on the Blake farm along the property line. He discussed

[1] Chief, division of engineering, Western Gulf Region, Soil Conservation Service, Fort Worth, Tex.

this problem with the district conservationist, who then asked the district supervisors to explain the situation to Ralph Blake and Fred Morris and to ask them if they would not like to have their farms planned in conjunction with George Stewart's. Since both men had been attempting to control erosion on their cultivated fields, they readily agreed.

The farm planner and engineer then visited this group of farms, taking careful notice of existing conditions and problems in each field, and discussing changes which should be made. Level readings were taken to determine the grade of existing terraces. They made frequent reference to the physical land-survey and land-use capability tables as a basis for decisions. The map at the left shows these three farms as they appeared to the planning group.

On the Blake farm the woods, Field 1, was not fenced and grazing and trampling had left the ground hard and almost bare. No selective cutting or stand-improvement practices had been followed. The run-off from a group of small springs in the woods was flowing into the pasture, Field 2, but there was no good watering place for stock.

The terraces in the north part of cultivated Field 4 had satisfactory grades but were somewhat lacking in channel capacity. They emptied on to well-established sod, and no erosion was occurring at the outlets. The land along the drainageway was being cultivated, however, and erosion was evident as a result of overflows. The terraces in the south part of this field had satisfactory grades, but they were emptying into a gully along the property line and the terrace channels were beginning to gully at the outlet ends.

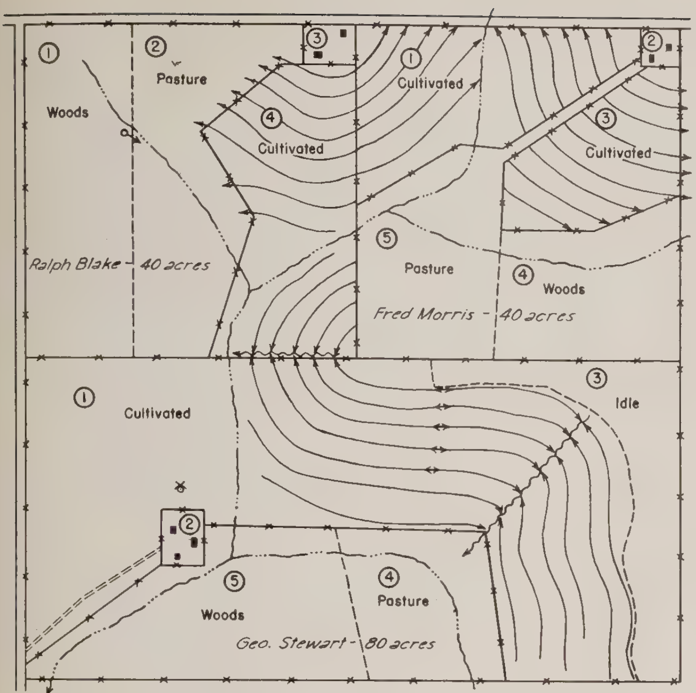
The terraces in the west part of Field 1 of the Fred Morris farm were small, had an average grade of 8 to 9 inches per 100 feet, and the four top terraces were emptying into a badly gullied roadside ditch. The same was true of the terraces in the east part of the field, and part of this slope was too steep and badly eroded to remain safely in cultivation. The fence along the roadside ditch was undermined by gullying. The terraces in Field 3 were in the same condition and were emptying across the property line on to an adjoining farm and causing gullying. The woods in Field 4 were not fenced and were in about the same condition as Field 1 of the Blake farm. The pasture, Field 5, was well sodded but was small, and no water was available except at the farmstead.

The west part of Field 1 of the George Stewart farm was in cultivation but not terraced, and was too badly eroded to remain safely or profitably in cultivation. The terraces in the east part of Field 1 had excessive grades and were inadequate in size. Most of them were emptying into a gully in the center of the field, but five were emptying across the property line into a gully on the Blake farm. Field 3 was a steep, rocky patch of idle land covered with weeds, scattered brush, and trees. The pasture in Field 4 was fairly well sodded but was too small for the needs of the farm and no water was available except from a tank at the farmstead. The woods in Field 5 were unfenced, grazed, and in poor condition.

The map at the right illustrates the plan for these three farms as developed by the planning group. The woods in Field 1 of the Blake farm are to be fenced and good management practices will be followed. A covered collecting basin will be built for the springs, and the water will be piped to a stock-watering tank to be built at the west side of the pasture, Field 2. The pasture will be mowed to control weeds, and no other treatment will be necessary. The terraces in Field 4 will be built up to adequate size as soon as the present cotton crop has been picked, and a recommended method of strip cropping will be used. The field road will be along the east property line.

The land adjoining the drainageway will be retired from cultivation and developed into meadow, to prevent further erosion damage and to provide a source of hay, and will become new Field 5. In new Field 6, the old terraces will be leveled, and new terraces will be built as an extension of the terraces in Field 4 of the Stewart farm, emptying upon the established pasture, Field 2, of the Morris farm. A recommended method of strip cropping will be used. A drainage agreement among the three land owners will be put into execution, and this will include responsibility for construction and maintenance. Access to this field is available only over the terraces, but this will not be necessary more than once or twice a year when crops are harvested.

The terraces in Field 1 on the Morris farm will be leveled, and new terraces of adequate size and proper grade will be constructed to empty into the road ditch. The county has agreed to cooperate with the soil conservation district and the landowners in executing a protective highway agreement as indicated along the north side of the Blake and Morris farms. In the section west of the culvert, the water-carrying channel which will receive run-off from the four terraces in Field 1 will be solid-sodded as soon as resectioning has been completed by the county, and the flumes on each side of the culvert will be solid-sodded. The side slopes of the west section and all of the east section will be broadcast-sodded.



Present

In the pasture, Field 2, a stock pond will be built to provide water for livestock. Core tests were made, and subsoil conditions were found to be favorable for the construction of a pond. The sodded spillway will be on the north side of the pond, to divert the run-off from the pond to the adjoining stable drainageway. The pond will be fenced, and water will be piped through the fill to a stock tank below. The upper part of Field 2, which is to be retired from cultivation to pasture, will be manured, sodded, and cultivated at least twice during the first growing season to establish a good cover as soon as possible.

The terraces in new Field 4 will be left as they are for the present. As soon as a cover is well established in the pasture, Field 2, the terraces will be leveled, and new terraces of adequate size and proper grade will be constructed to empty into Field 2. A recommended method of strip cropping will be used. The field road will be located next to the east property line. The woods in Field 5 will be fenced off from the pasture and proper management practices will be followed.

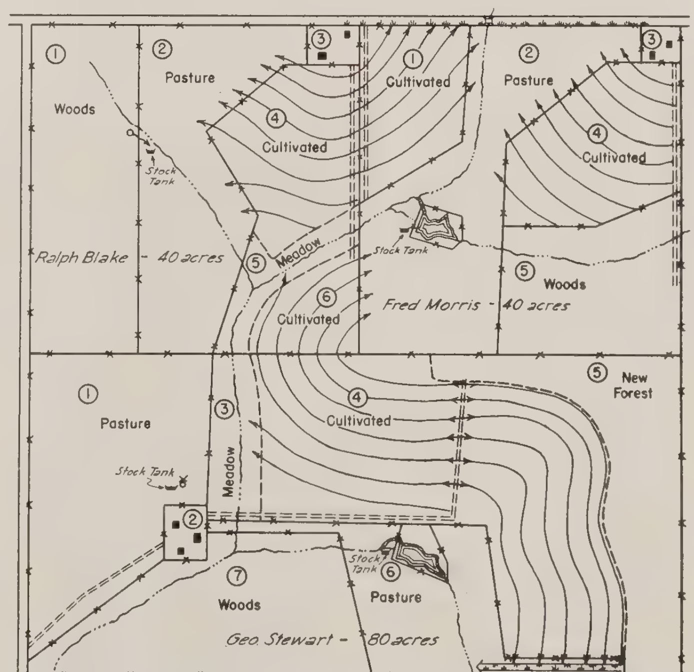
Field 1 of the George Stewart farm will be retired from cultivation, fenced, and sodded to pasture. Numerous small gullies will be plowed in, manured, and sodded. The field will be contour furrowed to keep as much water as possible out of the gullies. Water will be provided by a stock-watering trough to be built near the windmill on the farmstead.

The land adjoining the drainageway on the Stewart farm will be retired from cultivation and developed into a meadow as indicated, becoming new Field 3. In Field 4, the old terraces west of the field road shown will be leveled, and new terraces of adequate size and proper grade will be constructed to extend through Field 6 of the Blake farm and empty into the pasture, Field 2 of the Morris farm as described above. The old terraces on the other side of the roadway will be left to empty into the gully for the present until the short sodded channel at the south side of the field can be excavated and time allowed for the broadcast-sod to become established. This should be within a year, after which the old terraces will be leveled and new terraces of adequate size and proper grade will be built to cross the gully which was formerly used as an outlet and to empty into the short sodded channel. This channel will empty into the drainageway over a sodded flume. The upper terrace will be built with sufficient capacity to divert the run-off from the new forest, Field 5. A recommended method of strip cropping in connection with terraces will be used in Field 4. It should be noticed that the terraces were divided and run in opposite directions because of their length, and that this division point is the logical location for a field road.

Pine trees will be planted in Field 5, which was formerly idle land. A border strip of three to five rows of adapted shrubs will be planted between the pine trees and cultivated field. This border strip is for the purpose of improving conditions for wildlife and will prevent the eventual shading effect that the trees would have on the field crops.

In the pasture, Field 6, a pond will be built to provide a water supply for livestock. Core tests were drilled,

(*Continued on p. 195*)



Planned

LAND UTILIZATION DEVELOPMENT

By HUGH R. McCALL [1] AND ASSOCIATES [2]

THE development of nearly 7 million acres of purchased land—submarginal, cut-over, overgrazed, and otherwise misused—as initiated under the Resettlement Administration in December 1935, involved 94 land-use demonstration projects located in 41 States. The principal objective of the program was to achieve the best multiple use of this land through public ownership and management. Besides beneficial land-use adjustments the program provided employment in areas where the unabsorbed relief load was high and where the opportunity for other work projects was limited.

In the eastern half of the United States the utilization of the areas was directed toward nonagricultural uses such as forestry, recreation, and wildlife conservation. This required extensive timber-stand improvement and tree planting, construction of many impounding dams, and recreation facilities of all kinds. Hundreds of miles of roads and telephone lines as well as numerous administration and service buildings were provided. In the Great Plains and intermountain areas this adjustment has involved the development of range-improvement measures to facilitate constructive range management. On these projects hundreds of stock-watering places, miles of fencing, and extensive reseeding were needed. Grazing control and other water- and soil-conservation measures also were necessary.

Since 1937 the submarginal-land program has been conducted under authority of title III of the Bankhead-Jones Act, and development work was initiated on 22 additional projects after the entire program was transferred to the Bureau of Agricultural Economics by administrative order. More specific instructions by Congress concerning the types of land to be purchased under this act resulted in the formation of a program more strictly concerned with agricultural problems. The development work has consisted principally of improving the purchased lands for grazing and forestry purposes. Most of these later projects are located in the northern and southern Great Plains because of the pressing need for rehabilitation in this region. The greater amount of the work has been conducted in cooperation with State and local agencies.

The funds and labor, certified from local relief rolls, have been made available through the cooperation of the Works Projects Administration. At one time a maximum of 43,000 men were actively engaged in this development work and this number included many of the clients whose land had been purchased by the Government.

Following the reorganization of the Department of Agriculture in 1938, the administration of this program was transferred from the Bureau of Agricultural Economics to the Soil Conservation Service, where it has been integrated with other departmental programs for the conservation and proper use of lands.

The following summary of the major jobs completed during the period beginning in December 1935 and extending through the fiscal year 1938–39 will furnish some indication of the detailed nature, extent, and diversity of the work undertaken on these project areas.

Job classification		*Units completed*
Obliteration of fences	miles	7,333
Obliteration of farmsteads		5,320
Seeding	acres	185,380
Roads	miles	1,121
Truck trails	do	4,191
Bridges		1,482
Telephone lines	miles	2,287
Power lines	do	108
Lookout towers		162
Impounding dams		1,635
Earth dikes	miles	30
Administration buildings		144
Cabins		327
Work camps (146 total units)		28
Bathhouses and shelters		191
Other building structures (service buildings, equipment sheds, garages, barns, latrine buildings, etc.)		828
Camp fixtures		5,413
Public camp and picnic grounds	acres	11,996
Water-supply systems		345
Wells, pumps, and windmills (stock water)		505
Sewage-disposal systems		192
Fences	miles	6,045
Cattle guards		813
Corrals		55
Terracing	rods	210,285
Contour furrowing	acres	25,158
Check dams		389,058
Stand improvement	acres	452,402
Fire-hazard reduction	do	252,380
Trees planted and seeded		67,950,000
Stream improvement	miles	936

[1] Inspection engineer, division of engineering, Soil Conservation Service, Washington, D. C.

[2] Other members of the engineering division, particularly Messrs. E. J. Thomas, John B. Thomas, Louis Brandt, and William A. Holweg contributed material and data incorporated in this article.

Additional activities not included in this tabulation involve land clearing, quarrying and crushing rock for liming the land and for construction use, timber harvest, firebreaks, boundary markings, cover mapping, acquisition, topographic and drainage surveys, fish-rearing ponds and hatcheries, food and cover planting, and biological conditioning work.

Because of the extensive structural work involved, engineering has been a predominant feature in planning and supervising the development of these projects. The building of structures necessitated making surveys, plans, detailed designs, specifications, cost estimates, and work schedules to ensure efficient execution of the work. The important details of certain representative structural facilities are described in the following to show the great amount of engineering work involved.

Impounding Dams

A total of 1,635 impounding dams have been built to date. While all can be considered in the general category of small dams, a limited number are structures of considerable size. They range in type, size, and utility from the great number of small stock-water reservoirs serving the livestock grazing areas of the semiarid regions of the West to the larger rolled earth-fill and masonry gravity types constructed for water-conservation, wildlife, and recreational purposes.

In planning a network of stock-water reservoirs in a given area, the selection of individual sites was important from a range-management as well as a construction point of view. Factors requiring careful evaluation were the location of sites with respect to the distribution of grazing and accessibility for cattle, the impounding of the maximum volume of water with ample depth and minimum amount of earth embankment, the status of land ownership, the ratio of storage capacity to the estimated annual yield of the drainage area, and the adequacy and type of spillway best adapted to discharge economically the maximum expected flood flow. The physical dimensions of these reservoirs vary widely with local topography. In general, they range from 1 to 5 acres in area, with a maximum water depth of from 8 to 15 feet. The dam structure is usually from 150 to 400 feet in length, with an embankment volume up to 5,000 cubic yards. To date, over 700 of these structures have been built on the three Montana projects.

Other examples of small dams required under the program are the concrete and timber spillway types constructed across drainage ditches in the central Wisconsin and northern Minnesota areas.

The 1,500-acre Rynearson flowage at the Central Wisconsin Game project near Necedah, Wis., is controlled by two of these concrete structures capable of holding a 15-foot head of water and discharging the overflow through multiple 8-foot span openings. They are equipped with removable timber stop logs and, in addition, one structure has a 16- by 8-foot steel taintor gate, thus giving flexible control of water levels during periods of flood flow. The remaining integral part of this flowage is formed by 2.2 miles of shallow earth dike constructed across the flat sand and peat land depressions between protruding small islands in this glacial marsh area. On the 152,000-acre purchase area of both central Wisconsin projects, 30 miles of earth dike (350,000 cubic yards of embankment), 24 timber and 3 concrete spillway control dams have created an open water area over 8,000 acres suitable for the propagation of migratory waterfowl and fur-bearing animals.

On the Beltrami and Pine Island projects in northern Minnesota, 210 small timber ditch dams have been built to raise the water table previously lowered by the extensive drainage program carried out in this peat-bog area during the period 1912–17. Several hundred miles of ditch profiles have been run as a basis in selecting sites for optimum flowage. These ditch flowages have saturated the surrounding peat marshland, and thus they serve as an effective firebreak in this territory. These dams are also of inestimable value in providing conditions suitable for the propagation of waterfowl, small fur-bearing animals, and such big game species as moose, elk, deer, and caribou.

The larger rolled earth-fill types with reinforced concrete spillways and channels are represented by the Tierra Blanca Dam near Umbarger, Randall County, Tex., and the Greenwood Dam located on Furse Creek near Shoals, Martin County, Ind. These dams form a nucleus for an extensive recreational and wildlife development. The Tierra Blanca Dam is shown in the accompanying illustration.

The Greenwood Dam forms an 800-acre lake with 12,000 acre-feet of storage; it spans the flat valley of the Furse Creek with a drainage area of 13 square miles of rough, unglaciated terrain, typical of this section in southern Indiana. This valley, lying in a general east-and-west direction, has a large neck of high land projecting from the south valley wall to within 1,200 feet of the north wall, and thus it offers an excellent site for an earth-fill dam. A fill of 217,743 cubic yards that was 1,320 feet long and 16 feet across the top was used. Foundation explorations revealed

Tierra Blanca Dam, Randall County, Tex. Length of earth fill, 835 feet; top width, 16 feet; height, 53 feet; volume of fill, 135,379 cubic yards; volume of concrete, 2,960 cubic yards; length of spillway crest, 200 feet; length of spillway channel, 700 feet; width of spillway channel, 80 feet; reservoir area, 1,870 acres; storage capacity, 18,120 acre-feet; drainage area, 575 square miles; spillway capacity, 50,000 c. f. s. (200-year flood frequency); depth of water May 9, 1939, 19.3 feet; dewatering conduit, 4 by 5 by 200 feet (reinforced concrete).

that the site in years past had been the location of a natural lake with the high land reaching out as part of the old natural dam embankment. The original lake bed, now under 10 to 12 feet of topsoil, consists of a dense blue lake silt to a depth of approximately 50 feet. From a geological point of view, this depth of silt would indicate that the natural lake had occupied this bed for hundreds of years.

Because of the investment involved and the importance of protecting life and property, these and other large dam structures required a high standard of engineering design and construction. For earth-fill dams the material was placed in 6-inch layers and thoroughly compacted by the use of sheep's-foot roller equipment. The moisture content of the fill was also carefully controlled by sprinkling, and the latest principles and methods of soil mechanics were employed.

The spillways on the larger dam structures are either ogee, channel chute, or side channel, as best suits the site, and are constructed of either concrete or native rock masonry. In the designs, architectural and aesthetic effects have been combined to produce a pleasing appearance in harmony with the local surroundings.

As might be expected, a program of such a large number of dams gave rise to many engineering problems. One of the most difficult has been estimating flood flow that must be provided for. Not only factors of topography, geology, meteorology, climate, and vegetal cover are involved, but also the intangible matters of probability, economics, and public policy. The disposal of flood waters after passing through the spillway has been another important design consideration. Due to kinetic energy and velocity accumulated in the rapid transposition in elevation, water can cause great damage to the spillway, dam structure, or the valley below if unleashed without control.

The geological structure of the foundation frequently has been a major problem of design. Foundations must be stable and capable of supporting the structure. Further, they must be either impervious, or, if pervious, capable of transmitting percolating water at a safe low velocity so as not to disturb the soil particles. The volume of seepage must be restricted so that it will not cause any serious loss of water from a reservoir. In rock foundations, the existence of possible seams, fissures, faults, and limestone caverns must be investigated. If there is danger of excessive seepage, a deep cut-off, sheet piling, or pressure grouting may be required. In some instances a broad, impervious upstream apron will prove effective.

At the Storm Creek Dam near Helena in eastern Arkansas, the problem encountered was unique, because of a very peculiar geological formation and an unusual soil type. This dam is located in Crowley Ridge, a prominent topographical feature of the region, elevated 150 feet above the surrounding flat bottomlands of the Mississippi Valley. The ridge extends 125 miles in length and approximately 3 miles in average width. Its eminence is due to the effects of differential erosion by the great drainage systems of the region; the Mississippi River and its tributaries in Quaternary times have worn away vast areas on either side of the ridge, but by curious chance the stream cutting missed this narrow area. Subsequently, the ridge was capped by a thick deposit of wind-blown loess, which is now the dominant soil type of the area. This loess is an extremely fine silt and contains a negligible amount of colloidal material. The soil particles are elongated in shape and uniformly small and ungraded. The soil has an unusually low density, high porosity, erodes readily, and is almost impervious to percolating water. It also has a very narrow range of critical moisture content. In many characteristics it behaves in a perverse and paradoxical manner.

This was the material available for the construction of this large dam. The fill was deposited and spread in 6-inch layers and compacted by a heavy sheep's-foot roller making approximately 20 trips for each layer placed. Even with the greatest care the density obtained was only a dry weight of 87 pounds per cubic foot, or an increase of 12 percent over the weight in situ at the borrow pit.

A scene in the Sand Hills project, Hoffman, N. C., where 12 miles of trails have been reconstructed to form a sand-clay surface park road leading from main highways through the Indian Camp Park recreational area. Work involved clearing of 15 acres, excavating and grading 12,000 cubic yards, placing of 450 feet of 18-inch and 24-inch concrete pipe culverts, and building of 4 small timber bridges.

For the protection of the upstream face, a blanket of pit run gravel was applied having a horizontal thickness of 3 feet at the top to 10 feet at the base. It was deposited in layers concurrently with and rolled integrally with the rest of the fill. The upstream face was further protected against continuous wave action to a vertical height of 7 feet by firmly keyed sacked concrete. This type of riprap was employed as there was no rock available in this region. The downstream slope was protected by solid sodding of Bermuda grass to resist erosion. Riprap was also placed on the lower 12 feet of the downstream slope which is subject to backwater action caused by floods of the Mississippi River. This dam spans a broad valley and has a tributary drainage area of 9 square miles. It is 1,100 feet in length and 45 feet in maximum depth. Slopes are three to one upstream and downstream with a 30-foot width at the top. Approximately 250,000 cubic yards of embankment have been placed for this structure.

Buildings

The future public use and management of these project areas by State or Federal agencies has made imperative the construction of a great number of permanent building structures serving many different purposes. At administrative centers individual or combination units are necessary for tool and equipment storage, garage facilities, warehouse supplies, office use, and superintendents' quarters. Also, many dwellings are required for forest rangers, game managers, maintenance workers, or others having responsibility for management and supervision who must reside on the project. Complete engineering surveys are required in locating and planning the general layout of groups of buildings serving the various headquarters areas.

Recreational developments call for a variety of buildings such as bathhouses, boathouses, cabins, lodges, recreational buildings, and picnic shelters, which generally vary in style and type of construction according to their local environment. The general approach in the design of these facilities has been the so-called rustic construction. This enabled the utilization of project labor to produce native materials needed for construction. This is particularly important in the present stage of development, because of the limitation of funds imposed for the purchase of materials and supplies. On many projects sawmill operations also are carried on for cutting, drying, and planing the lumber used in the building of frame structures. On the Sand Hills project in North Carolina all lumber required for the fish hatchery and game farm buildings, in addition to the Millstone Group Camp and Indian Park Recreational Area, was provided by this method.

Organized group camps or recreational centers for 4-H Clubs and Boy and Girl Scouts have proved exceptionally popular. The buildings for most group camps consist of staff quarters, infirmary, administration building, dining hall and kitchen, numerous bunk cabins, bathhouses, toilet buildings, and a club or assembly building. An unusual example of this type of facility serving a dual purpose is the Lakeview Camp on the Allegan, Mich., project. Here a camp was provided to house 150 workers during the intensive stage of development operations on the project and later to be used as a permanent recreational camp for various youth organizations. These buildings have recently been given a more permanent exterior finish of beveled bungalow siding and new roofing. The camp is well landscaped and is situated on a promontory overlooking Lake Allegan, formed by the new Allegan Municipal Power Dam across the Kalamazoo River.

Sanitary Installations

One of the problems most difficult of solution is that of securing an adequate, safe, and potable supply of drinking water. This should be the first requisite in planning an administrative headquarters, group camp, or recreational area. Its importance, together with that of providing a safe means of sewage disposal, cannot be overstressed, as the future effective administering of these centers may be impaired by the inadequacy of sanitary installations. In fact, the development of a water supply should be given priority in construction, for the additional purpose of facilitating the building of other structural units.

In the construction of individual dwellings, it has been kept in mind that the water supply and sewerage installations should be of the type most suited to the respective locality and requirement. Although modern bathroom fixtures were considered desirable in residences where water could be made available under pressure, the hand pump was resorted to at many forest wardens' dwellings and workers' cabins where funds were limited. When the type of dwelling and demand justified power pumping equipment, a pressure tank, concrete reservoir, or elevated tank for storage was installed. Drilled wells with a minimum diameter of 4 inches were recommended, but smaller sizes were used when the drilling could be performed by project labor and a sufficient water yield secured for the requirements of the site. Water-carriage sewage-disposal systems have been constructed at individual dwellings where feasible. However, approved standard fly-proof pit privies were the only alternative when only a hand-pump water supply was available. Septic tanks having a minimum liquid capacity of 500 gallons with subsurface tile fields were built when water could be secured under pressure. Springs have been developed only when a sanitary survey indicated that their safety could be assured, and cisterns with filters were used where a well supply would have been extremely expensive.

At the larger recreational centers water systems involving elevated tanks or storage reservoirs with capacities of from 5,000 to 12,000 gallons were necessary. With these installations sufficient head and pressure were available for a gravity distribution system to the various parts of the recreational area. Dual systems using lake water for the showers and toilets were necessary when an adequate safe supply of water for all requirements could not be secured. To eliminate the possibility of infection through the use of these showers, the installation of portable chlorinators for treatment of water was recommended. The principal of chlorination has also been employed at swimming pools to maintain a consistent chlorine residual for protection of the health of the individuals using the bathing facilities.

The problem of providing for the disposal of sewage from all buildings or group camps or recreational areas has required numerous field investigations. Large septic tanks with siphons and adequate disposal fields based on soil percolation tests were constructed to serve the lodge buildings and camp groups. Separate individual systems were designed when the general terrain did not permit the serving of the entire area by one central system. The bathhouses had separate

Watchman's cabin for lookout tower, Allegan project, near Allegan, Mich.

shower-water disposal systems and the domestic sewage effluent only was carried to the septic tanks, thus permitting better operation of the treatment system. Imhoff tanks with trickling filters were not desirable due to the regular supervision these systems entail, and the possibility of odor nuisances unless they were located a considerable distance from the general use area.

The sanitary care of buildings as well as proper garbage and refuse disposal has largely been a problem of educating the public using these areas. In this connection a sufficient number of garbage containers and incinerators were placed at convenient locations for disposal of all refuse.

Other Structural Facilities

Other major structural facilities constructed under this program include 4,191 miles of truck trails, 1,121 miles of park roads, 1,482 bridges, 2,287 miles of telephone line, 162 lookout towers, and 6,045 miles of fencing.

Several of the original projects already have completed development and are turned over to administrative agencies, and a great majority of those now continuing development operations will be liquidated during the current fiscal year. Although the Soil Conservation Service is continuing to administer the major portion of the demonstration projects set up under this program, wherever it has been more appropriate the lands have been transferred to a State or Federal agency for permanent management. A considerable acreage already has been transferred to the Forest Service and the Biological Survey for incorporation into national forests and game refuge areas.

A forthcoming issue of SOIL CONSERVATION will feature other phases of the land utilization program.

THE WATER-FACILITIES PROGRAM

By KARL O. KOHLER, JR.,[1] AND JAMES A. MUNCEY [2]

THE water-facilities program is so designed that facilities are not to be developed "hit-or-miss" or for a great variety of purposes. Carefully planned water facilities are intended to achieve wiser use of land over a period of years and, through wiser land use, to promote the welfare of the people who live on the land.

According to the Water Facilities Act, facilities cannot be located where they will encourage cultivation of lands that are submarginal for agriculture. The benefits of the program are extended to bona fide farm or ranch operators—those whose lands are in actual use for agricultural or grazing purposes or may profitably be placed in such use as a result of water-facilities work. The intent of the act is to provide for a great number of small water facilities rather than a few large ones. It is expected that the majority of the individual facilities to be constructed under the program will cost less than $2,000 each; thus with the funds available a greater number of people will be benefited. In some instances larger, more costly facilities may be required, and to provide for these the Agricultural Appropriation Act of 1940 establishes $50,000 as the maximum amount of Federal funds to be expended for any one facility.

Only facilities that will benefit lands in private ownership will be built. Facilities are not installed on public lands except when it has been shown that they are necessary to provide needed water supplies for farm or ranch families on adjoining or interspersed non-Federal land.

Tenants as well as landowners may benefit from the program. Before a tenant can participate, however, he must provide security for the loan and the lease must be arranged to insure to him benefits that will offset his contributions to the cost of installation. A landowner must also provide security before a loan can be granted him. The security required will be based on a reasonable probability of repayment of the loan as reflected partly by the farm plan and partly by the present value of the security.

Under certain conditions it may be desirable to provide a facility that benefits a group rather than an individual. This can be done through the use of such an instrumentality as a cooperative association, a mutual water company, irrigation district, or a soil-conservation district.

To promote better land use for the maximum number of farm families in a drainage area where water supply is limited, careful planning for the watershed as a whole is required. In watersheds authorized for planning under the program, local farmers, acting through county agricultural land-use planning committees, take part in the development of the general plan for the area. These county committees function cooperatively with the State land-grant colleges and the United States Department of Agriculture. The Department's participation in this planning work is under the leadership of the Bureau of Agricultural Economics.

The Soil Conservation Service has been designated as the agency of the Government that will build or supervise the building of water facilities in areas which have been approved for operation. The Farm Security Administration will handle the credit aspects of the program.

Persons desiring to benefit from the program may consult the local representative of the Soil Conservation Service or the Farm Security Administration, the county supervisor, or the county agricultural extension agent. These men will know which areas are included in the program and whether or not help is available locally.

It is essential that a conservation plan and a farm and home management plan be worked out cooperatively with each individual farm or ranch served by a federally financed water facility. Therefore, every farmer benefiting must agree to carry out a farm plan as a consideration for receiving the financial and other assistance offered by the program. These farm plans will be drawn up by representatives of the Department and the cooperating farmer or rancher. They will provide for (1) the application of soil- and moisture-conservation practices, (2) improved land use, (3) a production plan that provides for repayment of loans and operating and living expenses, and (4) sufficient food and feed crops to meet the needs of the family and the livestock. The farmer must agree to maintain the facility during its useful life.

The amount of the loan that the farmer is expected to repay will depend upon his ability to repay. Ability to repay will be determined by the Department. The number of years the loan will run will depend on

[1] Chief, regional engineering division, Soil Conservation Service, Amarillo, Tex.

[2] Chief, regional engineering division, Soil Conservation Service, Spokane, Wash.

Figure 1.—A sketch of the ranch near Tascosa, Tex., showing the facilities developed under the water facilities program.

the expected life of the facility, but in no case will it exceed 20 years. Interest will be at the rate of 3 percent per annum. The Department will not ask reimbursement for its assistance in engineering, legal matters, and farm management; that is, it will not expect reimbursement of the costs of general administration of the program.

The program offers Federal assistance in constructing, installing, repairing, or rehabilitating the following specific kinds of facilities: Ponds; reservoirs; wells; detention, retention, and diversion dams; pump installations, including windmills; spring developments; water spreaders; stock-water tanks; facilities for flood irrigation and small irrigation facilities, either for individual families or small groups of families; facilities for recharging underground reservoirs.

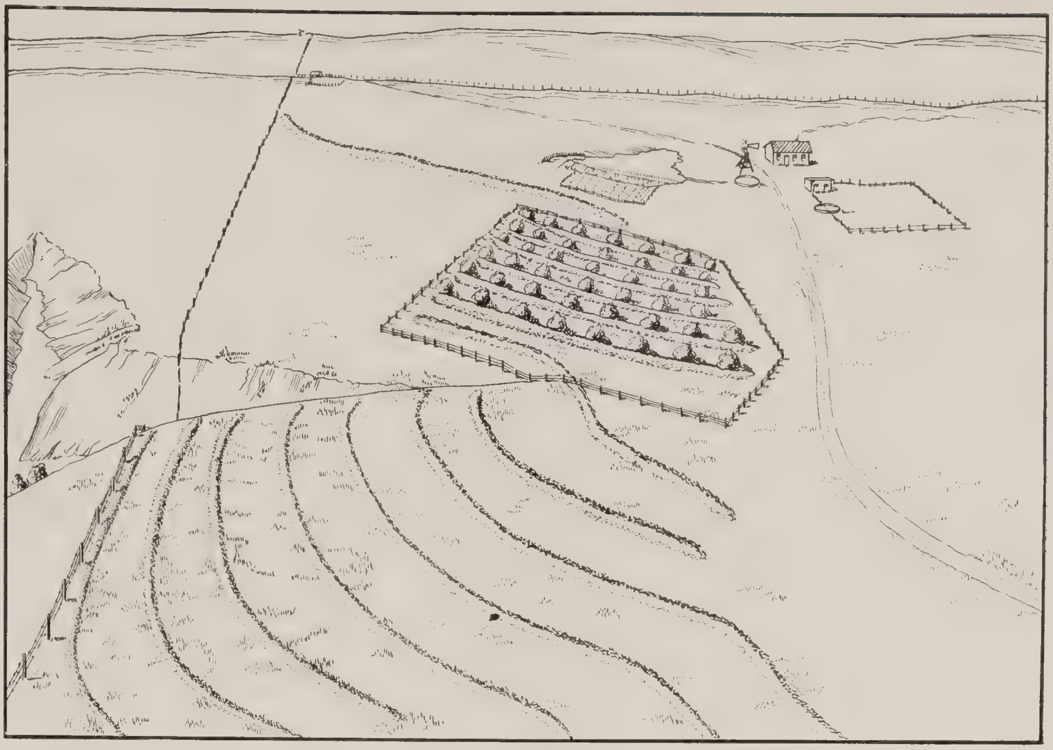
Only such facilities may be provided which in actual operation will effect the storage or utilization of water for stock or farmstead use or for its application to farm gardens, crop or hay lands, range or pasture lands, or other lands used for agricultural purposes.

Actual construction and installation of facilities can be handled either by (1) having the Department do the job, or (2) by making the necessary funds available to the benefiting farmer or rancher (or cooperative association) and having him assume responsibility for getting the job done.

A family living near Tascosa, in the Texas Panhandle, had long dreamed of a maximum development of water facilities on their ranch of some 3,700 acres. They knew that such development was possible; but it was not until technical services and reasonable cost of financing as provided by the water-facilities program were made available that their dream approached realization. An analysis of the situation as it existed on their ranch revealed that they had two major problems, the production of supplementary feed for their livestock, and serious annual floods. The sketch (fig. 1) shows a more complete picture of this problem.

Surveys revealed that the flood damage was being caused by flash run-off, from 337 acres of rough broken land, that was draining into a draw which overflowed on to fields and damaged orchard, roads, and farmyard. To prevent this damage, an earth-fill dam was constructed across the draw above the farmstead. A diversion was also constructed to intercept water flowing across the farmyard and divert the flow into the reservoir. This retention dam is approximately 800 feet long, 12 feet high at the maximum, has a crown width of 12 feet, and contains approximately 7,000 cubic yards of fill. Side slopes are 2 : 1 downstream and 3 : 1 upstream, with the upper face riprapped with rock. A storage capacity of 30 acre-feet is provided, and grain fields below can be irrigated by discharge of water through an 8-inch pipe through the dam. Because of the gradual percolation of water into the sandy soil, it is not anticipated that much water will be available for irrigation from this reservoir. This is considered an advantage, however, in that it provides a recharge for several springs which outcrop just below the farmstead. An adequate spillway is provided to take care of expected floods. Water discharged from the spillway is spread over pasture land to provide intermittent irrigation for the grass.

Figure 2.—A view of the water facilities installed on the Texas Panhandle farm.



Development of irrigation facilities for the production of a dependable source of supplemental feeds was of fundamental importance on the ranch. Prior to this development the discharge from the several springs below the homestead had been stored in two small ponds having a combined capacity of about 15 acre-feet. Water from these ponds was used to irrigate 10 acres of orchard and to provide water for livestock. Since the capacity of these small ponds was not adequate to impound all the discharge from the springs it was decided to provide additional storage. To do this a second earth-fill dam was constructed below the two small ponds, and thus an additional 30 acre-feet of storage was provided. This dam is approximately 800 feet in length, has a maximum height of 16 feet, a crown width of 12 feet, and contains approximately 15,000 cubic yards of fill. The design calls for slopes of 2 : 1 downstream and 3 : 1 upstream with the upstream slope also riprapped with rock. Water may be discharged for irrigation through a 15-inch corrugated-iron, paved-invert pipe controlled with a vertical 15-inch cast-iron gate operated from a substantial catwalk. To supplement the spring flow, a diversion channel was constructed to divert run-off water from 100 acres of pasture land into the reservoir. Directly below the reservoir lies a 45-acre field. This entire field can be irrigated from the reservoir and is to be planted to alfalfa. Leveling operations have been completed and ditches and laterals constructed. The production of alfalfa on this field, for feed to supplement the grain sorghums grown on nonirrigated lands. is a valuable contribution to the ranching program.

The dams were constructed with 60-hp. crawler-type tractors and 6-cy. (capacity) carry-alls. Earth was placed in layers of 6 to 8 inches and well compacted. The owners gave splendid cooperation during the entire construction; they contributed a large part of the labor, operated the equipment a part of the time, did all the rock riprap work, fence work, construction of the catwalk on the second dam, and were a constant inspiration to the construction crews. The total cost of this facility was approximately $3,500. Of this amount the owners contributed about 50 percent in labor and materials. The owners will repay the remaining 50 percent to the Government over a period of 20 years.

A farmer in Hartley County, in the Texas Panhandle, also is thankful for the service provided by the water-facilities program. Before the development of this facility he had no water either for livestock or domestic use. Domestic water was hauled from a well at an abandoned farmstead three-fourths of a mile distant. Since he had no stock water on his farm he could not utilize his own grazing land, but had to arrange to graze and water his livestock on a neighboring farm. His tenure was very insecure; it was necessary to renew the lease annually. Through reorganization of his plan of operations, which was a requirement in the development of plans for the facility, he secured a 12-year lease making it possible for him to construct improvements (fig. 2) with confidence.

Water was provided from a well 380 feet deep cased with 6-inch casing. A 12-foot windmill on a

32-foot wooden tower was installed. Water is pumped through 2-inch tubing and has proved ample for livestock and domestic purposes. The windmill was located on a high spot where the operator has since built a new house. Overflow from the windmill is carried into a storage tank which was constructed by damming up a small draw. Run-off from the draw, together with the overflow from the windmill, will be stored behind this small dam. Provision is made for irrigation of a 1-acre garden plot directly below the dam by discharge of water through a pipe. The installation of this facility has made it possible for the farmer to keep several head of dairy stock with which he will supplement his income by selling cream. The skimmed milk will be fed to his hogs. Below the stock pond is a wide, flat meadow in which abundant natural grasses have grown in the past. The surplus water from the pond together with a diversion of run-off water from an adjoining area will be utilized to flood-irrigate this grass. A spreader system of dikes has been installed to spread the water over the grass. Plans have also been made for planting a few fruit trees above the dikes to provide fruit for home use. Any surplus water from this spreader system is diverted on to grassland which has been contour furrowed; this is done in order to utilize every drop of water. Diversion of water from this draw is also preventing further development of a deep gully that has been eating up the draw from below and eventually would have destroyed the meadow. The total cost to the farmer for this facility, which includes the well and windmill, dam, and all other work described, is $940; he agreed to repay this sum within 10 years. The useful life of the facility is estimated at 20 years or more. Thus it is possible through planning to take advantage of all natural resources, that a simple windmill installation can be used as a means of completely reorganizing and rehabilitating a unit, to make it a paying enterprise.

In both of the examples just described a conservation plan and a farm- and home-management plan were worked out in addition to the structural work just described. These plans called for the application of soil- and moisture-conservation practices, improved land use, and an adequate production program.

Thirteen families inhabit the Sublett Valley, a narrow strip of land about 7 miles long and ½ mile wide, in southern Idaho in an isolated community that derives the major part of its livelihood from the livestock industry. Rehabilitation of their irrigation district, through which water is obtained for the production of stock feed, is typical of numbers of similar possible developments under the water-facilities program in the western United States.

The project will consist of reconstruction of the storage dam that serves the 13 farms (fig. 3), drilling of several wells for winter stock water, and general reconditioning of the irrigation distributing system.

Sublett Dam, at the upper end of the valley, was constructed in 1912 for irrigation water storage. It is 37 feet high and 570 feet long, with a capacity of 1,490 acre-feet. The dam has no overflow spillway, so that it has been necessary to control storage through a 3-foot circular concrete conduit. As there were only two wells in the valley proper the conduit was left partly open during the winter months to make stock water available for the ranchers. This has resulted in reduced winter storage. The reservoir storage and natural creek flow during the irrigation season were sufficient to irrigate all of 645 acres and partly irrigate 272 acres. Including 552 acres of additional irrigable land for which there was no water, a total of 1,469 acres is available in the valley for irrigation.

Upon completion of subsurface investigations and location of sufficient fill material the engineering design was drafted to include the following items:

1. Increase of 11 feet in height of the present dam, which would increase the storage 900 acre-feet. (This, with stream flow, is adequate to irrigate the entire 1,469 acres.)
2. Construction of new outlet conduit pipe with new control gate. (The old conduit had been fractured due to fill settlement.)
3. Construction of an overflow spillway through a ridge southeast of the dam.
4. Placement of an impervious blanket around the south abutment of the dam to reduce seepage loss.
5. Placement of two cut-off trenches under the new fill.
6. Construction of a system of drains under the downstream toe of the dam.

Plans were then completed for the drilling of nine combination stock and domestic water wells, and for revisions in the irrigation distribution system to include (1) water-measuring devices, (2) diversion dams and divider boxes, (3) enlargement and realinement of present ditches, (4) installation of individual farm turnouts, and (5) revision of the irrigation systems on the farms.

In conjunction with the structural program a plan of conservation operations was written to establish a long-time better land-use program for all lands to be

(*Continued on p. 195*)

OUR DRAINAGE PROBLEMS [1]

By JOHN G. SUTTON [2]

FEW people realize that such a large amount of our high-grade agricultural land is dependent upon drainage. Forty-four percent of the land area of Indiana is in organized drainage enterprises. A large portion of the northwest quarter of Ohio, formerly called the Black Swamp, has been drained and now constitutes the most productive agricultural area of the State. The extent of drains required is indicated by the fact that Wood County, lying in the midst of the Black Swamp area, has 2,350 miles of public drains.

In 1930 the census of the United States reported 84,408,093 acres of land included in organized drainage enterprises. Almost all these enterprises were formed for the construction of public drainage works and structures in accordance with the State laws, and private drainage enterprises less than 500 acres in size were not included. This acreage represents approximately 4.4 percent of the total area of the United States, or the combined areas of Illinois, Indiana, and Ohio. Table 1 shows the distribution of these drainage works by States, and the drainage enterprises in the eastern part of the United States may be located by referring to the accompanying map.

The rate of development of drainage enterprises as taken from the 1930 census is shown in table 2. Approximately 60 percent of the land in enterprises and 63 percent of the invested capital is in drainage projects organized during the 15-year period, 1905 to 1919. The average cost per acre was considerably more from 1915 to 1924, inclusive, than during other periods.

The above discussion relates to organized drainage enterprises. Such enterprises are essential and have been provided where physical land problems necessitated group action rather than individual action or action through mutual agreement. In addition to public drains the drainage of individual farms by means of tiles and open drains is necessary for a large proportion of our flatter lands, although there are no accurate figures to indicate the total extent or cost of private drainage. According to the 1930 census

TABLE 1.—*Summary of drainage work of organized drainage enterprises by States (From United States drainage census of 1930)*

State	Land in enterprise	Improved land in enterprise	Length of ditches	Tile drains	Levees	Pumping plants	Capital invested
	Acres	*Acres*	*Miles*	*Miles*	*Miles*	*Horsepower*	*Dollars*
Ohio	8, 165, 494	7, 604, 274	25, 048	9, 371	0	25	36, 836, 449
Indiana	10, 214, 014	9, 361, 457	20, 787	10, 439	132	166	54, 110, 854
Illinois	5, 032, 682	4, 745, 840	5, 996	3, 826	1, 108	18, 658	75, 048, 548
Michigan	9, 180, 851	7, 663, 256	17, 189	3, 490	35	275	37, 677, 084
Minnesota	11, 474, 683	7, 396, 575	14, 478	9, 451	150	75	64, 139, 641
Iowa	6, 137, 649	5, 961, 454	4, 800	13, 382	113	4, 625	77, 478, 893
Missouri	3, 150, 022	2, 309, 267	4, 961	123	931	2, 533	47, 340, 174
North Dakota	1, 094, 142	1, 075, 259	818	10	0	0	3, 148, 919
Florida	5, 954, 934	783, 033	5, 113	0	718	5, 065	45, 487, 795
Mississippi	2, 988, 496	1, 950, 356	4, 022	44	228	370	23, 601, 443
Arkansas	4, 631, 155	2, 614, 427	4, 974	0	202	515	37, 532, 575
Louisiana	3, 655, 483	2, 267, 737	7, 701	2	576	6, 495	20, 752, 645
Texas	2, 833, 356	2, 011, 044	3, 662	9	216	510	12, 002, 949
California	2, 233, 714	2, 007, 987	4, 606	486	1, 390	41, 748	66, 451, 698
Other States	7, 661, 418	5, 762, 115	14, 519	4, 399	740	18, 687	79, 123, 213
Total of United States	84, 408, 093	63, 514, 081	138, 674	55, 032	6, 539	99, 747	680, 732, 880

TABLE 2.—*Rate of organization of drainage enterprises*

Date of organization	Area, all enterprises	Area overlapped	Additional land	Ratio to total land	Capital invested, all enterprises	Average investment per acre
	Acres	*Acres*	*Acres*	*Percent*	*Dollars*	*Dollars*
Before 1870	1, 056, 844	137, 727	919, 117	1. 1	1, 263, 389	1. 20
1870–1879	3, 480, 915	963, 973	2, 516, 942	3. 0	11, 317, 896	3. 25
1880–1889	9, 549, 227	3, 496, 420	6, 052, 807	7. 2	28, 035, 384	2. 94
1890–1899	11, 265, 052	5, 307, 549	5, 957, 503	7. 0	32, 838, 911	2. 92
1900–1904	12, 380, 936	4, 715, 113	7, 665, 823	9. 1	34, 139, 656	2. 76
1905–1909	23, 862, 554	5, 534, 537	18, 328, 017	21. 7	111, 612, 254	4. 68
1910–1914	22, 331, 693	5, 883, 316	16, 448, 377	19. 5	125, 953, 183	5. 64
1915–1919	23, 422, 034	7, 619, 132	15, 802, 902	18. 7	190, 583, 008	8. 14
1920–1924	12, 735, 739	5, 307, 560	7, 428, 179	8. 8	102, 976, 838	8. 09
1925–1929	8, 410, 084	5, 121, 658	3, 288, 426	3. 9	42, 012, 361	5. 00
Total, all enterprises	128, 495, 078	44, 086, 985	84, 408, 093	100. 0	680, 732, 880	5. 29

[1] On July 1, 1939, the drainage and irrigation activities of the Department of Agriculture that are related to the land, including the C. C. C. drainage camps, were transferred to the Soil Conservation Service.

[2] Head, drainage and irrigation section, engineering division, Soil Conservation Service, Washington, D. C.

650,172 farms, totaling 44,523,685 acres, reported private drainage, but the census report states that these figures were too low, which undoubtedly is true.

During the decade, 1910 to 1919, lands that could be cheaply drained were becoming scarce and many high-cost reclamation projects were undertaken. For example, many lands requiring levees and pumps in addition to the interior drainage system were drained; these projects required a high bond cost per acre and often too little time was allowed for investigations and planning. Some of these projects were abandoned, but most of them drained good lands and are still operating. Some projects paid their indebtedness in full. Many projects defaulted on their outstanding indebtedness, and these defaults were so extensive that in 1933 the Reconstruction Finance Corporation was authorized to refinance drainage enterprises in financial distress. This agency's latest report shows that, on an outstanding indebtedness of over 80 million dollars, loans to the extent of over 34 million dollars have been authorized for refinancing. More than 69,000 farms were benefited and the average savings on annual charges were about 75 percent.

In considering the large areas of lands in drainage enterprises the thought may occur to some that the totals include some lands which should not have been drained. This is true because there are areas of considerable size, particularly those in northern Minnesota and the Florida Everglades, which have not proved adaptable to agriculture under present conditions. Outside these two areas it is doubtful whether 3 percent of the drainage enterprises based on total area would now be classed as submarginal by comprehensive land-use surveys, providing the land had proper drainage treatment. This does not mean that all of the remaining 97 percent has been profitable to the organization, but it does mean that the drainage has reclaimed wet lands which now furnish livelihood to farmers who should be able to keep the project alive.

Projects that could be completed at reasonably low cost have been generally successful, providing they had good soils as a basic resource and effective drainage was secured. A few enterprises have been undertaken which drained principally sand, gravel, peat, or other unproductive soils. These mistakes could have been avoided by careful soil investigations before undertaking the projects. Through faulty design or construction some projects did not render effective drainage. The correction of such difficulties constitutes an important drainage problem.

Some drainage projects, unfortunately, were undertaken without regard to proper wildlife programs for the immediate area. It is now generally recognized that conservation of wildlife is one of the essentials of a good land-use program. Some marsh areas should be devoted to this purpose, and it is not in accordance with good land use to drain the last acre of marsh land in any section. Through the work of the Biological Survey, State conservation departments and other agencies, considerable land is being placed under public control to solve the problems met in the conservation of wildlife.

The Maintenance Problem

Aside from all questionable areas, there still remain tremendous areas of good agricultural lands that are dependent upon drainage. These are the lands with which the Service is primarily concerned. Probably the most important of our problems in relation to these lands is to secure continuous maintenance of established drainage enterprises. There is much room for progress in financial, organizational, and physical aspects of maintenance. The maintenance generally has not been adequate; ditches have been dug and allowed to grow up in trees and brush and to silt up. Without maintenance this would continue in most communities until enough landowners were damaged, through low crop yields and loss of crops, to secure wide local support for new assessments. Some of the landowners would normally go bankrupt in the process because of unfavorable locations of their lands. Owners of the lands having fair natural drainage would tend to resist additional expenditures until rising water levels affected them. The C. C. C. drainage camps, many W. P. A. projects, and other State and Government activities have been undertaken in recognition of the necessity of proper maintenance of public drains.

The financial aspects of the problem cannot be overlooked, and some State drainage laws could well be revised to facilitate maintenance work. To perform a maintenance operation, some States require assessments, court approvals, legal and engineering procedure, almost as complicated and expensive to the farmer as the organization and establishment of a new drain. In other States the responsibility is placed on local elected officers and often they postpone necessary maintenance work in response to local complaints against levying additional taxes. It has been found that more adequate local maintenance is given in those drainage enterprises where the volume of annual maintenance justifies continuous employment of a person or staff whose sole responsibility is the maintenance work. In many instances the expense of maintenance, together with the retirement of the original

Location of land in Drainage Enterprises in the Eastern United States

Taken from the 1930 U.S. Drainage Census

bonds, has been so high that subsequent taxes could not be paid. This encouraged postponement of maintenance work. In many enterprises the landowners do not appreciate the necessity of maintenance and extensive educational work is necessary. In other enterprises large acreages of idle lands have been one of the principal factors causing defaults and neglected maintenance. Productive lands must be utilized to secure self-supporting enterprises.

Many of our present problems are strictly technical in character and involve some fault in design or construction. Difficulties of this kind occur so frequently

that it is pertinent to point out the necessity of conducting technical phases of drainage operations under the supervision of engineers thoroughly familiar with the standard practices covered in the numerous textbooks on drainage and experienced in such operations.

The C. C. C. Drainage Camps

In 1935 the Bureau of Agricultural Engineering was allotted 46 C. C. C. camps to work on the rehabilitation and reconstruction of existing drainage improvements of which seven camps have been discontinued.

TABLE 3.—*Location of original and present drainage camps* [1]

State	Original	Present
Dalaware	2	2
Maryland	3	4
Ohio	9	6
Indiana	8	6
Kentucky	2	2
Illinois	6	5
Iowa	5	4
Missouri	6	4
Louisiana	5	5
Michigan	....	1
Total	46	39

[1] One additional drainage camp is scheduled for Mississippi, Apr. 1, 1940.

The primary objective of the work of C. C. C. drainage camps is to rehabilitate the drainage improvements of organized drainage districts, county drains, and other public ditches or drainage works constructed or maintained in accordance with State laws. Another objective is to establish demonstrational projects to serve as examples of improved design, construction, or maintenance.

To anyone not familiar with the condition of public drains in 1935, it is difficult to picture their general condition after years of neglect. Very little maintenance work had been done for many years prior to the depression, and practically none during the years 1930 to 1935. Most ditches had become completely overgrown with brush and trees and the capacity of many neglected channels had fallen to one-half or even one-fourth of that necessary for proper drainage and flood protection. Tile lines had been neglected also, and tile had become filled up or broken so that many lines were ineffective. Levees were overgrown with brush and vegetation and often were so weakened by groundhogs and other rodents that they could not withstand a minor flood.

The work of C. C. C. projects has included clearing vegetation from drains, excavating ditches, clearing and repairing levees, cleaning tile lines, and repairing or improving other drainage structures such as pumping plants, headwalls, and ditch structures. The work on unimproved creeks, rivers, and other drainage channels is limited to that required to furnish a satisfactory outlet and to protect works constructed by an organized drainage enterprise. All camp work is confined to projects benefiting lands which are unquestionably of high agricultural value when properly drained. Projects that would bring additional land in cultivation, keep in cultivation lands of poor fertility or of submarginal character, or reclaim new farm units, have not been undertaken. No work has been done on private drains.

Wherever possible, the camps have encouraged construction of complete demonstration jobs. A complete ditch job includes clearing, excavating to grade, construction of necessary structures to prevent and control silting, seeding the side slopes to stabilize banks, and treatment of spoil banks. Ditches with 2 to 1 and, in a few instances, 3 to 1 side slopes have been built as experiments and demonstrations. These flatter slopes have been seeded to grass so that they could be pastured or mowed. Leveling spoil banks to permit cultivation or pasturing to the edges of the ditches has been encouraged where it was apparent that this was proper use for the land involved. The drainage camps have undertaken the rehabilitation of numerous tile drains which failed as a result of improper construction, clogging, or damage. Many tile outlet structures also were repaired or reconstructed. The construction of levees to proper grade, and with sufficiently flat slopes to be safe, has been encouraged together with seeding, pasturing, and fencing of levees, as there is little doubt that a well-pastured sod furnishes the best vegetative covering for a levee.

The drainage camps have secured substantial cooperation from local drainage enterprises on nearly all work projects. The total cooperation secured by camps listed in table 4 averaged $2,307 per camp month. This investment encourages local people to accept responsibility, to take a greater interest in the drainage works, and to continue maintenance as a regular activity after the C. C. C. drainage camps are withdrawn.

The readiness of landowners, drainage officials, and drainage organizations to cooperate in this undertaking has been one of the chief factors in the success of the work and has enabled the camps to accomplish a much greater volume of work and to undertake more difficult jobs than otherwise would have been the case. The chief contribution of the Government has been the labor of the C. C. C. enrollees and one or two small draglines per camp to facilitate organization and

(*Continued on p. 194*)

RESEARCH PROBLEMS IN CONSERVATION ENGINEERING

By MARK L. NICHOLS [1]

THE primary objective of the Soil Conservation Service is to develop a sound and practical program of soil and water conservation and put that program into effect on the farm lands of the United States. This is rather a large order. In the first place, it involves almost everything in agriculture, and this means that we must consider not only the physical problems, which are sufficiently complicated in themselves, but the social, political, and economic problems as well. Naturally, there is need for great variety of skills and techniques and for people with a wide range of training and experience.

In my opinion, putting the various elements together into a practical farming program, instrumenting them with methods and equipment and placing them into operation on the land, is engineering. There are those who insist that conservation is primarily good agronomy and others who insist that the basic consideration is soils. There is no doubt in my mind but that they are both right, nor do such claims conflict with the statement that the entire program is agricultural engineering in the broader sense. In this article we shall disregard the divisions of science set up for administrative reasons in the Department of Agriculture and State institutions, and discuss engineering problems in conservation as farm problems that involve engineering, but certainly not to the exclusion of other branches of agricultural science. For convenience of discussion, the subject is broken down into two parts conforming in a general way with common engineering subject-matter classification.

Machinery Problems

Regardless of the fundamental soundness of the conservation program, it cannot be put over with the farmer unless the methods of application are worked out to a point where the farmer can be shown by demonstration exactly what to do and how to do it. In general, any program of conservation of cultivated or bare land consists of parts or combinations of the following practices: (1) Interception by channels or levees of concentrated waters flowing across the area to be conserved; (2) maximum surface protection of the area by good agronomic practice, usually consisting of proper rotations, maintenance of a high level of organic matter, and strip cropping to disperse concentration and to permit good tillage practices with proper row arrangement; (3) means to conduct excess rainfall from the land with the minimum of erosion; (4) removal from cultivation of areas too steep for cultivation under general farming practices—such land can be used for permanent pasture or woodlots.

The second consideration is of primary importance in machinery studies. Probably this can best be illustrated by a specific example: In the area around Presque Isle, Maine, the chief industry is the production of potatoes. Very high yields are common in this area and although there is only a short growing season the climate seems particularly adapted to the production of this crop. The distance to the market, however, is such that the shipping costs are high. These conditions naturally result in a broad development of this industry through extensive methods of agriculture using power machinery. Under these conditions, the potato land is fallowed or plowed up in the fall and left bare during the winter and this results in extensive soil loss through the melting of snow. Large-scale operation for a short period of time naturally requires large machinery—two-row planters and diggers and spray rigs handling many rows at the same time. Under this system the rows have been run up and down hills, and summer storms remove vast quantities of soil from the fields.

Obviously, here is an engineering research problem of major importance, and upon its solution depends the permanent welfare of a large area in northern Maine. I am informed that the first device used to solve the problem was that of putting the potato rows on the contour. The effect of this was such that moisture conditions became so changed as to result in heavy loss of potatoes in the field. Moreover, because of the slope there were serious complications in machinery operation due to side slippage. It seems obvious that there is some mean between the contour and the up-and-down-hill arrangement of rows that can be worked out to allow the minimum of erosion within the moisture tolerance of the crop. To meet this there must probably be some modification either in the use or in the present design of equipment. In all probability, if long rows are to be used as conditions indicate that they are necessary, interception of run-off

[1] Assistant chief, in charge of research, Soil Conservation Service, Washington, D. C.

must be provided, either by drainage-type terraces or by some other device that will not interfere too seriously with the use of large equipment. Such development would be of great benefit not only to the Aroostook County area but also to other areas throughout the whole Northeast. In this connection, the problem of handling the waters of melting snows to prevent erosion is being attacked by the use of what we may call for want of a better term, a "snow terrace" superimposed upon the ordinary terrace system to prevent plugging with slush during thaws.

Problems in the use of machinery in conservation are of course not limited to the potato areas of the Northeast. American agriculture has been keyed to the maximum production per man of necessary commodities by large machinery. In some instances extensive use of this power has resulted in an exploitive type of agriculture that has brought about the destruction of the land itself. The most outstanding example is the Dust Bowl. Some find fault with the tractor, and power farming itself, as a cause; and while this in some respects is justified, it is the abuse of the method rather than any fundamental wrong in it that has caused the destruction. One might as well find fault with good food because many people injure themselves by overeating. In my opinion, however, it is of basic importance that the agricultural engineer direct his energies toward the development of methods by which this equipment can be used to promote conservation. The power itself can be made to become an instrument of conservation if properly directed.

Under the old system large quantities of roughage were produced to feed horses and mules for power. The reduction of this food requirement naturally has increased the amount of land available for salable products and undoubtedly it has had an effect upon the markets as well as upon erosion. It is a matter of considerable importance for us to consider the use of this equipment in producing cover crops and feed crops for other types of animals and for soil building.

Most of this engineering experimentation must be coupled with and based upon new soil-building developments and agronomic practices. We know that favorable soil structure and resistance to erosion are closely related to the organic-matter content of the soil and its microbiological associations. For example, material reduction in erosion can be attained by the use of mulches, and it has been the practice for some time in the far West to use a trashy fallow to prevent wind erosion. This use of plant residues to prevent erosion involves, for practical application, and under present conditions, the employment of machines. One farmer in the far West has developed a machine that leaves practically all the straw on the surface, tied down just enough by the soil so that the wind does not blow it. Another farmer in Georgia has for a number of years successfully maintained good production in cotton without plowing; he leaves the plant material and organic matter on the surface, in balks between the cotton rows. Several State experimental stations are now engaged in research involving the retaining of plant cover and other crop residues at or in the surface, in such a way as to leave an effective mulch during most of the season.

The engineer has a very important and practical role in such developments. Our position in the Federal or State service is such that we must try to determine what needs to be done and to cooperate with manufacturers of equipment to find how the job can be accomplished by machines. We are working on the principles upon which designs must be based, and we leave the design to the manufacturer who must consider the many and varied problems of machine production. In the vast majority of cases, however, the ends we desire can be accomplished with machines now in production. For example, one of the main terracing problems is maintenance of the terrace channel. Experience shows that this can be accomplished efficiently as part of the regular farming procedure by varying the methods of plowing and using perhaps one or two special operations to keep the channel clear. The development and application of strip cropping systems—an important and practical conservation operation—generally can be handled with present equipment; but the width and length of strips must be adjusted to the use of the equipment the farmer now possesses. The entire machinery use must be studied and field practices varied if efficiency is to be maintained with various crop combinations.

Hydrologic Problems

In the Eastern States hydrology has not received much attention as an agricultural problem except as it applies to drainage. A few pioneers have done some work toward collecting the run-off data from small areas for use in the design of outlet ditches or terrace outlets; but there is a decided lack of information in this particular field. Up to a few years ago only two or three experimental stations and the Soil Conservation Service had data from experimental plots and a few small watersheds. In the field, conservation engineers in general were forced to fall back on guesses based on data gathered from storm sewer discharge.

There is a considerable volume of data on run-off of rather flat lands, gathered as a result of drainage experience, but this cannot be applied to steep lands where soil conservation is the chief problem. At the present, the Army and interested bureaus of the Department of Agriculture are engaged in getting together the best information available for flood-control purposes. The Forest Service has considerable data from forested areas, gathered during the past few years, but their work can be said only to be well under way, and their information cannot be applied generally to cultivated areas. Power companies, the Geological Survey, the Army, and other agencies have data from large watersheds.

In general the leading authorities on hydrology are not in agreement as to the effect of land use on run-off when it comes to quantitative evaluations of specific practices, although there are few who still believe that this is not a most important consideration. Congress has recognized the importance of land use in controlling run-off, by making the Secretary of Agriculture jointly responsible with the Secretary of War for flood control.

The Department of Agriculture and a number of State experimental stations are now seriously engaged in starting studies to determine specifically what can be done as regards run-off through the use of various land-use practices. In general these studies are directed at specific practices intended to use the soil and underlying strata (1) as a storage to regulate stream flow and (2) to reduce the drought hazard as far as possible by utilizing all the rainfall available in drought periods.

Many studies are being initiated on methods of inducing greater infiltration of water. Usually these are based on combinations of agronomic practices such as keeping up good covers and incorporating large quantities of organic matter in the surface of the soil (mulching) and upon engineering practices such as terracing or contour furrowing.

If we limit the term infiltration to the act of water going into the soil and entirely dependent upon surface conditions, we must also consider the permeability of the lower soil horizons and their maximum transmission capacity (defined as the upper limit of permeability). Many studies of permeability and transmission capacity are under way. Such studies must be made for most of the soils of the country, or indices of transmission capacity must be found and proved. Fortunately it appears that transmission capacity is frequently, if not generally, in excess of the infiltration rate, so that studies of methods of increasing infiltration are promising of practical results. If we find methods of keeping the surface pores or channels open by protection from slacking, packing by rain or poor tillage, or other packing or clogging, we can put very great quantities of water into the soil. It is recognized, of course, that various kinds and depths of soil and substrata limit this reservoir capacity; but in a majority of conditions throughout the United States the capacity, considering rainfall and its distribution throughout the season, is sufficient to be a most important factor in flood-control and water conservation. It must also be recognized that surface and subsurface conditions are always changing and that capacity in some soils, as well as permeability, may be completely changed by swelling or wetting, destruction of channels formed by roots, earthworms, etc.

There are many problems of a physical nature that are still practically untouched except in a very general way. Some of these are as follows: The retardation of flow by various vegetations; the effect of such surface detention on infiltration; the rate and energy of flow where surface tension phenomena play an important part, as in overland flow; the effect of slope and surface roughness coefficients; and so on, through a whole category of unknowns.

When one considers, as cause and effect, the general relationship between these energy-of-flow reactions and the resistance to erosion of the soil; and when one carries these studies to the point where practical results can be obtained by (1) reducing quantity of rainfall excess and consequently the total kinetic energy of the water through shortening slope length (i. e., interception with terraces or other channels) and (2) decreasing the erodibility by including organic matter; and when one realizes here that organic matter induces microbiological action, binding the soil together with mycelium and "bacterial mucilage," and reinforcing the entire surface and subsurface structure with plant roots and stems and their associated mycorrhiza; and when one is cognizant, at all times, of the constantly changing nature of the entire system set-up with season and exposure, with human and animal interference, and that over all and behind the present looms the effect of past history with resultant levels of fertility and natural plant associations and successions—surely there can be no question as to the need for research and no need to search for studies. The only question is where to start unraveling such a tangled thread.

There are numerous other problems of importance that can only be touched upon here, but for the pur-

(*Continued on p. 194*)

SOME PRELIMINARY RESULTS FROM RUN-OFF STUDIES ON DEMONSTRATION PROJECTS

By D. B. KRIMGOLD,[1] JOHN L. WEBER,[2] AND N. E. MINSHALL [3]

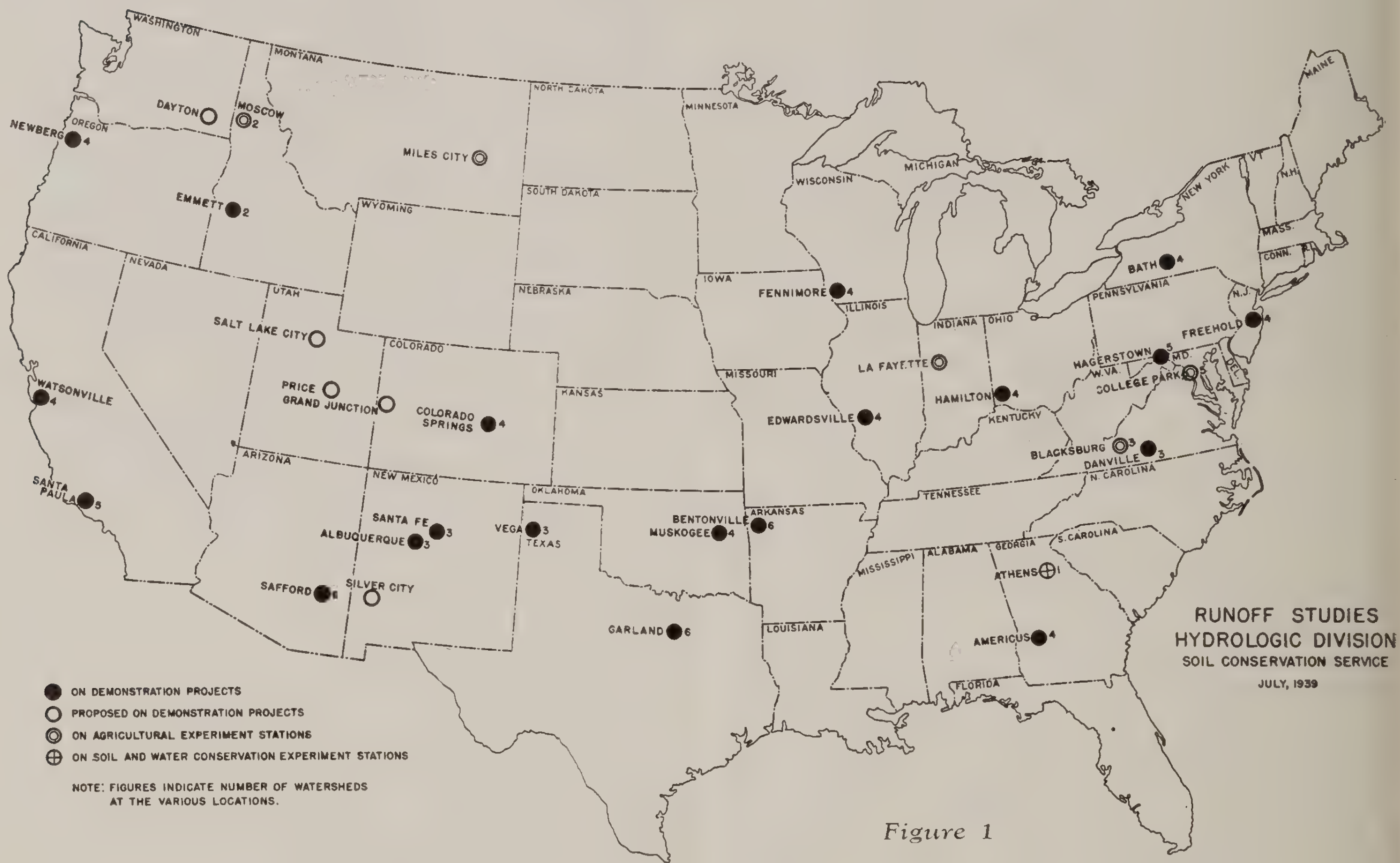


Figure 1

MOST of the rainfall and run-off stations established in connection with run-off studies on 20 of the soil conservation demonstration projects (fig. 1) have been in operation for 1 or 2 years. This is too short a period from which to expect sufficient data as a basis for design.

Some rather interesting records have already been obtained, however, on a number of the projects. For example, J. H. Dorroh, Jr., line project leader, reported an unusual rainfall record secured by J. S. Watkins, observer, on the Safford, Ariz., project. This rain of 2.84 inches in 85 minutes was recorded by three recording rain gages on a 380-acre watershed near Safford on August 2, 1939. This drainage basin is entirely in range land, and preliminary surveys indicate that the cover is largely grass with mixed browse. The slopes range from 5 to 25 percent with an average of about 20 percent. The soils are stony and sandy loam mesa derived largely from granite. The record from the centrally located gage shows the following distribution: 1.47 inches fell in the first 15 minutes; 0.73 inch in the next 15 minutes; and 0.64 inch in the remaining 55 minutes. It also shows that the maximum amount that fell in any 15-minute period was 1.60 inches. This greatly exceeds the 15-minute rainfall to be expected once in 100 years in this locality, according to Yarnell.[4]

An extrapolation of the data given by Yarnell indicates that the expectancy of this 15-minute amount is somewhere in the neighborhood of once in 500 years. This of course gives only a rough idea of the expectancy. It must also be remembered that the data given in the bulletin are probably based on records from Phoenix and Flagstaff, Ariz., El Paso, Tex., and possibly Roswell, N. Mex., none of which could truly represent the rainfall in the foothills of the Graham

[1] Soil conservationist, hydrologic division, research, Soil Conservation Service, Washington, D. C.

[2] Hydraulic engineer, hydrologic division, research, Soil Conservation Service, Washington, D. C.

[3] Associate agricultural engineer, hydrologic division, research, Soil Conservation Service, Fennimore, Wis.

[4] David L. Yarnell: Rainfall-Intensity-Frequency Data. U. S. Department of Agriculture Miscellaneous Publication No. 204.

Mountains near Safford, Ariz. The run-off resulting from this rain cannot be accurately compiled until the necessary maps are available. A preliminary examination of the record indicates, however, that the maximum rate exceeded 900 c. f. s.[5], which is 2.37 c. f. s. per acre or 1,500 c. f. s. per square mile—a considerable rate for this size of drainage basin. Without a complete discussion of the characteristics of the watershed and of antecedent conditions, the above run-off values do not mean much; they are, however, an indication of the type of data that already have been obtained.

A large number of records were obtained on other projects, notably Freehold, N. J., Hagerstown, Md., and Bath, N. Y., in Region 1, where the rainfall and run-off stations have been in operation longer than on any of the other projects. Most of the data, including those from Region 1, cannot be made available because the necessary surveys and maps have not been completed. But as a result of the interest of regional and project offices in Regions 5 and 6 and the untiring efforts of Messrs. R. P. Weeber and H. K. Rouse who were assigned to the studies on the Edwardsville, Ill., and Colorado Springs, Colo., projects, respectively, all the preliminary work has been completed and the records from these projects are in very good shape. For this reason the results from these two projects are discussed in this article.

The rain of August 10, 1938, on watershed W–IV at Colorado Springs is worthy of note. The permanent characteristics of this 35.6-acre watershed are shown on the soil and topographic map (fig. 2). The land has never been cultivated and represents foothill inceptive type of grassland. The cover and tillage map for the year of 1938 (not shown) gives the following description of cover conditions as of July 18, 1938:

Type area No. 1 (33.2 acres):

- Blue grama: Density 6 percent; average height 2 inches.
- Other short grasses: Density 2 percent; average height 4 inches.
- Club moss: Density 6 percent.
- Forbs and weeds: Density 2 percent; average height 8 inches.

Type area No. 2 (2.4 acres along watercourses):

- Blue grama: Density 33 percent; average height 4 inches.
- Sedges and rushes: Density 0.5 percent; average height 5 inches.
- Forbs and weeds: Density 1 percent; average height 10 inches.

The records from two recording rainfall stations on this watershed show a total of 1.91 inches in 63 minutes. Of this amount 0.67 inch fell in the first 15 minutes, 0.99 inch in the next 15 minutes, and 0.25 inch in the remaining 33 minutes. The 0.99 inch in 15 minutes exceeds the 15-minute rainfall to be expected once in 10 years and is nearly equal to that to be expected once in 25 years, according to United States Department of Agriculture Miscellaneous Publication No. 204.

The run-off resulting from this rain began 16 minutes after the beginning of rainfall. The maximum rate of 87 c. f. s. was reached 13 minutes after the beginning of run-off. The peak rate of 87 c. f. s. lasted for only a fraction of a minute. However, a rate in excess of 43 c. f. s. persisted for 15 minutes. Since in the Great Plains total yields are as important if not more so than maximum rates, it may be well to point out that the total run-off amounted to only 0.67 inch or 2 acre-feet. Sixty-five percent of the total rainfall was thus retained on the watershed. This is significant in view of the rather high intensities of rainfall. It indicates a rather high rate at which the water was entering the soil during this storm. The characteristics of the soil, as shown by the column descriptions in figure 2, and the fact that this rain was preceded by a rain of only 0.30 inch on July 26 and 0.05 inch on July 28, may explain the larger amount of water retained.

A discussion of whether and how the "rational formula" ($Q=CIA$) should be used is beyond the scope of this paper. In view of the misconception which apparently still exists, however, the writers consider it advisable to point out that the run-off coefficient, C, in the rational formula is not the ratio of the total run-off to the total rainfall but is the ratio of the rate of run-off to the rate of rainfall. If one takes the so-called "time of concentration" to be the period between the time of beginning of run-off and the time of maximum rate of run-off (13 minutes in this case), the coefficient of run-off would be 0.56 or 0.61 depending on whether one uses the maximum rainfall intensity for any 13-minute period preceding the time of maximum run-off, or the intensity for the particular 13 minutes between the time of beginning of run-off and the time of maximum rate.

It was already stated that, according to United States Department of Agriculture Miscellaneous Publication No. 204, the expectancy of 0.99 inch of rain falling in 15 minutes is about once in 25 years. This expectancy may or may not hold for the maximum rate or the total amount of run-off. At the time this rain occurred the condition of the watershed was not conducive to high rates of run-off. Had the same

[5] Cubic feet per second.

rain occurred when the soil was saturated or frozen, or had the high intensities in this rain been preceded by low intensities for a fairly long period of time, much higher rates of run-off and total yields would have resulted. A study of past records may show, however, that the probability of such a rain occurring when the soil is frozen or saturated is remote. It is also possible that in this locality where heavy precipitation results from convectional storms, high intensities always occur at the beginning of the rain. In view of the above it is not possible to arrive at the expectancy of this run-off without a study of past records of rainfall with particular reference to the time of the year, antecedent rainfall and temperatures, as well as intensity distribution. After such a study is made the probable expectancy of this run-off may be determined and the maximum rates of run-off in cubic feet per second per acre obtained from this watershed may be recommended for use in estimating run-off from watersheds with similar characteristics.

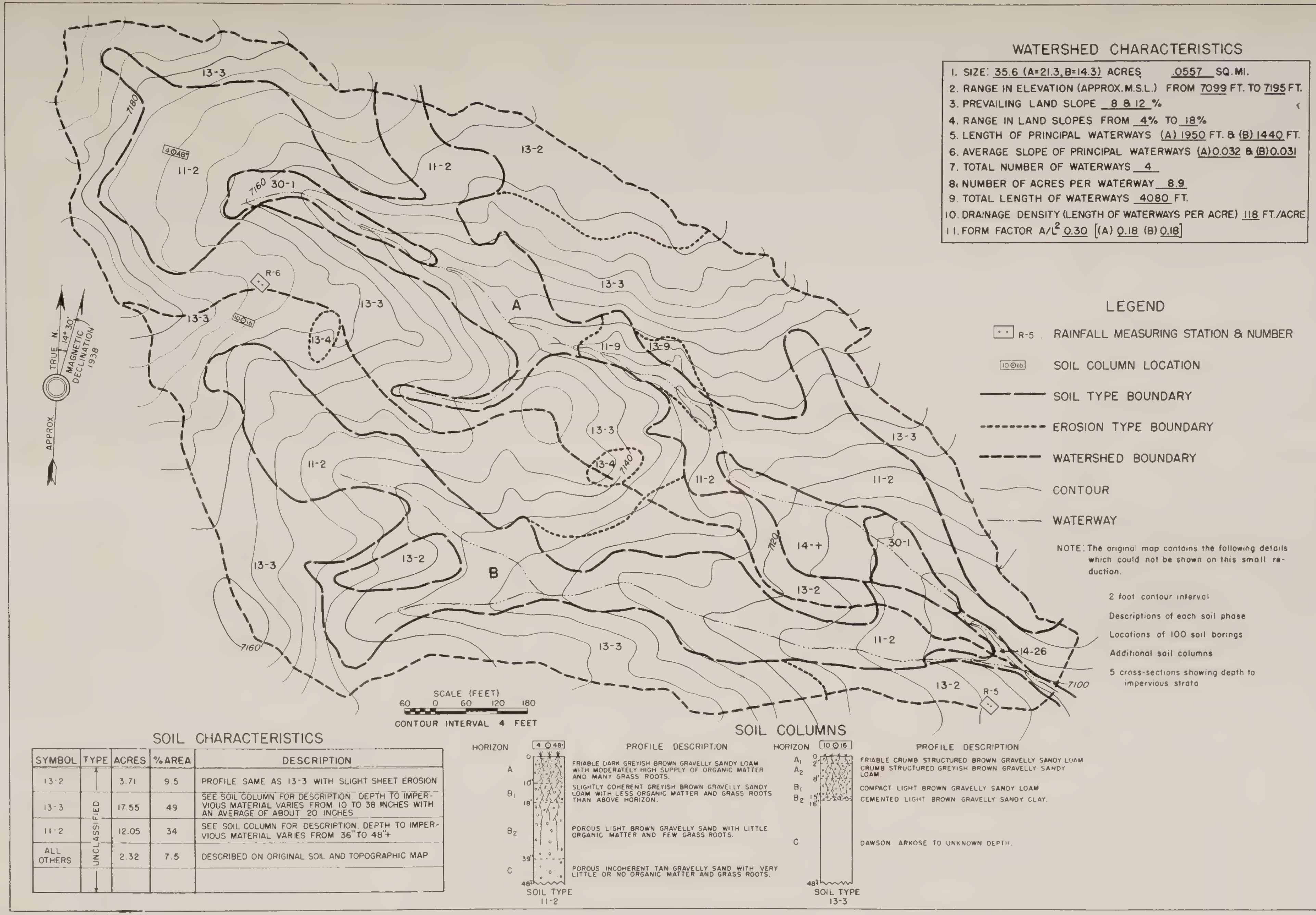
Of the run-off records secured on the Edwardsville project, those of March 30 and July 17, 1938, are the most outstanding. Other records secured in the summer of 1939 offer interesting comparisons. Maps similar to figure 2, as well as cover and tillage maps for the run-off periods mentioned above, are available for the four watersheds on this project. Lack of space does not permit including them in this paper. An attempt will be made, therefore, to outline briefly the characteristics of these watersheds before the records are discussed.

Watershed W–I is a nearly level, rotation-cropped area of 27.22 acres located on the James Love farm 5 miles northeast of Edwardsville. The area is fan-shaped with two main tributaries and with a difference in elevation of 20 feet from the measuring weir to the highest point in the watershed. Approximately 75 percent of the area has a slope of less than 2 percent while the maximum slope for a small area near the weir is 10 percent. The main soil type is Bogota silt loam, with small areas of Alma silt loam and Drury fine sandy loam, all of which have a fairly impervious subsoil. This watershed is divided into three fields. In March 1938, field 1 (7.5 acres) was in corn stubble; field 2 (14 acres), in bean stubble; field 3 (4.5 acres), in wheat about 3 inches high. The remaining 1.22 acres were in pasture. During the summer of 1938 the cover consisted of corn in field 1, small grain seeded to alfalfa in field 2, wheat seeded to sweetclover in field 3, and pasture on the remaining 1.22 acres. The crops for 1939 were: wheat seeded to sweetclover in field 1, alfalfa in field 2, corn in field 3, and pasture in the remaining 1.22 acres.

Watershed W–II is located on the William Eaton and Love estate farms a short distance from W–I. This watershed, with an area of 49.95 acres, is approximately $1\frac{1}{2}$ times as long as its greatest width and has a difference in elevation from the measuring weir to the highest point in the watershed of 40 feet. The topography is rolling with slopes of 0 to 5 percent on the uplands which drop off rather abruptly into well-defined water courses. The main soil types are Bogota, Alma, and Elco silt loams all of which are quite severely eroded. Approximately 90 percent of the area is in permanent pasture and the remainder in a rotation-cropped field.

Watershed W–III consists of a 12.55-acre terraced hillside located on the Mathilda Buchta farm about 5 miles north of Edwardsville. The run-off from this area is carried by six terrace channels to an outlet channel located on one side of the area. The terraces have an average length of 1,100 feet with a total drop of 3.5 to 4.0 feet. The vertical spacing of the terraces is 5 to 7 feet. The terrace outlet is a sodded channel about 10 feet wide having a total length of 550 feet and an average slope of 6 percent. The slopes of this area vary from 3 to 15 percent with an average of 8 percent over a large part of the area. Ninety percent of the area is Alma silt loam with moderate sheet erosion. The entire area is in one crop during any year, the 1938 cover being wheat seeded to sweetclover and the 1939 cover was corn.

Watershed W–IV is 289.8 acres in size. It includes all of areas W–I and W–II previously discussed and is located on the James Love and William Love estate, and the William Eaton and Edward Halbe farms. The watershed is nearly circular in shape, with serious erosion over most of the steeper portions or about one-third of the area, and has a well-defined drainage system with two main tributaries. The upper portions of the area are quite flat, but the slopes become very abrupt near the stream channels with some of them as steep as 30 percent. The difference in elevation from the highest point in the area to the run-off measuring station is 63 feet. There are four small stock ponds in this area draining a total of approximately 20 acres. These ponds all have tile outlets and the run-off from the areas above them may or may not be contributed to the run-off at the station, depending upon the depth of water in these ponds at the time of the rain. The soils of this area are mainly Bogota, Alma, and Elco silt loams with smaller amounts of Whitson and



SYMBOL	TYPE	ACRES	%AREA	DESCRIPTION
13-2	UNCLASSIFIED	3.71	9.5	PROFILE SAME AS 13-3 WITH SLIGHT SHEET EROSION
13-3		17.55	49	SEE SOIL COLUMN FOR DESCRIPTION. DEPTH TO IMPERVIOUS MATERIAL VARIES FROM 10 TO 38 INCHES WITH AN AVERAGE OF ABOUT 20 INCHES
11-2		12.05	34	SEE SOIL COLUMN FOR DESCRIPTION. DEPTH TO IMPERVIOUS MATERIAL VARIES FROM 36" TO 48"+
ALL OTHERS		2.32	7.5	DESCRIBED ON ORIGINAL SOIL AND TOPOGRAPHIC MAP

Figure 2, Soil and Topographic Map, Watershed IV, (R. & R. Ayer), Colorado Springs, Colorado.

Drury fine sandy loam. Approximately, 30 percent of the area, which includes most of the steeper portions, is in permanent pasture while the remainder is mostly rotation-cropped.

On March 30, 1938, a rain ranging from 1.58 inches on W–II to 1.85 inches on W–III occurred between about 3 a. m. and 8 a. m. This 5-hour rain produced run-off on all four watersheds. Between about 7 p. m. and 9 p. m. on the same date another rain ranging from 2.24 inches on W–I to 2.45 inches on W–III occurred on the four watersheds. A partial record of the evening rain and the resulting run-off on the several watersheds is given in the following table.

Item	W–I, 27.22 acres	W–II, 49.95 acres	W–III, 12.55 acres	W–IV 289.8 acres
1. Total rainfall . . . inches	2.24	2.30	2.45	2.37
2. Duration of rainfall . . . minutes	125	104	110	125
3. Time of beginning of rainfall (p. m.)	6:56	7:00	6:50	6:56
4. Time of beginning of run-off (p. m.)	7:00	7:00	6:50	6:56
5. Time of maximum rate of run-off (p. m.)	7:40	7:34	7:11	7:44
6. Maximum rate of run-off . . . c. f. s.	62.2	132.4	47.4	399
7. Maximum rate of run-off . . . c. f. s. per acre	2.28	2.65	3.78	1.37
8. Time interval between beginning and peak of run-off . . . minutes	40	34	21	48
9. Maximum amount of rainfall that fell in the intervals shown under item 8 . . . inches	1.55	1.52	1.39	1.86

In view of the morning rain it is safe to assume that the soil on all the watersheds was quite saturated when the evening rain occurred. The fact that the run-off resulting from the evening rain began within 4 minutes af the beginning of rain on W–I, and simultaneously with the beginning of the rain on the other three watersheds, indicates that not only was the soil saturated but practically all of the depression storage was filled at the time this rain occurred. We are, therefore, dealing with watershed conditions that are most conducive to maximum rates and amounts of run-off. The resulting maximum rates of run-off are shown in the above table.

The total run-off from W–I was computed and found to be about 2 inches which constitutes nearly 90 percent of the total rainfall. It will be noted that the maximum rate of run-off in cubic feet per second per acre was greater on W–II than on W–I although W–II is almost twice as large as W–I and 90 percent of it is in pasture while 95 percent of W–I is in cultivation. Other things being equal, one would expect a smaller rate per unit area from a larger watershed. The higher rate on W–II is no doubt due to the steeper topography and to the severe erosion. The high rate of 3.78 c. f. s. per acre from W–III is partly due to the somewhat higher total rainfall, greater rainfall intensities, and steeper slopes as well as to the size of this area.

If we assume the time intervals given under item 8 in the table to be the "times of concentration" of the various watersheds for this storm, the amounts given under item 9 would be used to determine the rainfal intensity I in the rational formula Q=CIA. United States Department of Agriculture Miscellaneous Publication No. 204, referred to above, does not give the expectancies occurring in the time intervals given under 8 of the table. A rough estimate of what the expectancies would be in accordance with this publication was obtained by interpolation. It was found that the expectancies on W–I, W–II, and W–IV were of the order of about once in 5 years. The expectancy on W–III was once in 10 years.

While in the case of the Colorado Springs record heretofore discussed the expectancy of the run-off may conceivably be the same as that of the rainfall, it is highly improbable that the expectancies as set forth above would apply to the Edwardsville March 30 run-off. The above mentioned publication gives the expectancy of various amounts of rainfall falling in certain intervals of time at any time of the year, but does not give the expectancies of such amounts falling in any particular month or season of the year. This again brings out the necessity of studying past rainfall records in the manner mentioned above before expectancies of run-off can be arrived at. It is quite probable, and past records no doubt show, that a rainfall of 1.55 inches in 40 minutes can be expected to occur during the summer months, once in 5 years. It is highly improbable, however, for such a rain to occur with the same frequency in March. Again, the probability of such a rain in March being almost immediately preceded by a gradual rain of more than 1.50 inches is even more remote. It is, therefore, quite possible that a further study of past records would show this run-off to be of an expectancy of once in 25 years or more.

In connection with the above discussion it will be interesting to examine some of the summer records from these watersheds. Next to the March 30, 1938, run-off rates the ones resulting from the July 17, 1938, rain were the highest thus far obtained. The total of this rain was about twice that of the evening rain of March 30, 1938, its duration was considerably longer and the intensities were generally smaller. The run-off rates resulting from this storm were less than half of the March 30, 1938, rate for W–I, W–II, and W–III and slightly more than half for W–IV. On July 16, 1939, a rain of 2.84 inches, with intensities only slightly less than those of the rain of March 30, 1938,

(*Continued on p. 194*)

Erosion-Control Lessons From Old-World Experience

IV. PRECEDENTS IN THE CONTROL OF WATERS

By W. C. LOWDERMILK [1]

PROVISIONS of the Omnibus Flood Control Act of 1936 require the Department of Agriculture to recommend and carry out approved measures for run-off and water-flow retardation and soil-erosion prevention in the interests of flood control. Of special interest to conservationists of the United States, therefore, are the fruits of 700 years of experience in England in dealing with surplus and flood waters which have ripened into an Act of Parliament.

The Land Drainage Act passed by the Parliament of Great Britain on August 1, 1930, was drafted on the basis of findings of a Royal Commission appointed in 1927 to find a solution to the confusion in the whole matter of land drainage, including flood control, and its administration. The Act authorizes the Minister of Agriculture to designate catchment areas of the main rivers as administrative units, and to set up Catchment Boards with wide powers of coordination and administration of the control and use of waters.

The Royal Commission of 1927 found a heterogeneous collection of 361 drainage authorities, exclusive of award authorities, in control of about 2,892,000 acres of land in England and Wales. Fully 4,362,000 acres of land depended on arterial drainage for their productivity, and 1,755,000 acres were in urgent need of drainage.

The confusion and conflicts of the multifarious authorities had grown out of a long experience with independent drainage boards and authorities. The first such authority was the board of officials of Romney Marsh which has been in existence for nearly 700 years.[2] This ancient authority with its laws and customs furnished a model for the Commissioners of Sewers under the Statute of Sewers in 1531. The powers of the commissioners were later codified in 1833, and again under the Land Drainage Act of 1861. In addition there grew up during the 17th, 18th, and 19th centuries a great number of drainage authorities, in all 198, established under private and local Acts of Parliament. Another type of authority was established when common lands were being enclosed at the end of the 18th and the beginning of the 19th century to provide drainage for portions of such tracts. Still other authorities, about 114, were brought in under the Land Drainage Act of 1861. The Royal Commission of 1927 found in all 361 multifarious authorities uncoordinated and conflicting, leading to confusion.

The Act of 1930 was drafted, on the basis of the recommendations of the Royal Commission, to the effect that one authority should have charge of water control of a catchment area of each of the main rivers, with exclusive control over the main channel; and that it should derive its resources from the entire catchment area. The Act further authorizes the Minister of Agriculture and Fisheries to delimit catchment areas and to constitute Catchment Boards of such numbers of members as the Minister may determine, not in excess of 31. They are designated and appointed by the Minister in the following way:

(a) One member appointed by the Minister.

(b) Not less than three of the remaining members are appointed from their own numbers by councils[3] of the counties (rural counties) and of the county boroughs (cities) which lie in whole or in part within the catchment areas.

(c) The remaining members are appointed by the Minister after consultation and consideration of the nominations of the internal drainage district boards, whose districts lie within the catchment area. These members coming from local drainage districts are called the "low-land members" of the Board, and make the major contributions to the Board's expenses.

The powers of the Act confer on the Catchment Boards sole authority of the "main river" as designated on the official map, including the river banks and drainage works in connection with the main river. Authorities over water courses of all kinds, from watershed divides to the sea, are brought under unified jurisdiction. The authority extends to the sea or estuary shores abutting on the catchment, for purposes of providing an adequate outfall for the main river. It also extends to those works which provide for irrigation in the uplands; it provides for maintaining water levels during droughts and it may extend to control and ownership of accretions of land from

[1] Assistant chief, Soil Conservation Service, Washington, D. C.

[2] Report of Operations and Proceedings under the Land Drainage Act, 1930, Ministry of Agriculture. London, 1937.

[3] The County Councils are equivalent in authority to county commissioners or county courts of the United States.

silt deposits in estuaries resulting from works of the Board to provide for adequate water outfall.

After the catchment area is delimited and the Board is constituted, the Board is called upon to prepare and submit to the Minister of Agriculture and Fisheries a scheme for the river, which is to include:

(a) Provisions for the transfer to the Catchment Boards of all rights, powers, duties, obligations, liabilities, and of any property held by preexisting authorities within the catchment area.

(b) Proposals for alteration of boundaries of internal drainage districts, for amalgamation of all or parts of any internal drainage district, for abolition of powers and schemes of Commissioners of Sewers; for abolition of internal drainage districts and the boards thereof; for the constitution of new internal drainage districts within the catchment area; for amending regulations of existing boards, and in other ways for assuming full authority for all agencies and activities within a catchment area having to do with flood control and land drainage.

(c) Bylaws, which are to govern the administration of the catchment area, including internal drainage boards.

The Catchment Board is given powers of general supervision of drainage within the catchment area, to secure efficient working and maintenance of existing drainage works and the construction of new drainage systems, and to give such guidance as is necessary to the internal drainage boards with respect to their powers and duties.

The Catchment Board thus coordinates the plans and activities of internal drainage districts. Only where necessary will the Board take over the administration of an individual district. Rather it is the plan to retain the small drainage district's administration in force, but to readjust boundaries where advantageous, and to harmonize regulations for the conduct of the details of administration and collection of rates. Moreover, the Board has authority and power to construct or alter or maintain any works for drainage within its area in the interests of efficiency. Any questions arising out of conflicts are referred to the Minister for decisions; a report, with reasons for the action, is laid before Parliament for review.

In the event of conflicts involving the operation of other public or local acts, the Catchment Board may submit to the Minister for confirmation a scheme for revoking, varying, or amending such provision. The Minister may approve or amend any such scheme, except that when opposed it shall be provisional only and shall not have effect until confirmed by Parliament

In accordance with a stipulated procedure, the Catchment Board may exercise the powers of any internal drainage district in default, to prevent injury or possible injury of lands by flooding or inadequate drainage; and the Minister may transfer to a Catchment Board all powers, rights, and effects of an internal district.

A Catchment Board must take steps for the commutation of all obligations imposed on persons to do work in connection with the "main river," as determined by the Board to be just. In determining sums to be paid for the commutation of obligations, an interesting stipulation provides that no obligation will be waived which would reduce the discharge of tributaries into the main river as a result of changes in methods of cultivation of fields. Obviously, the intent here is to safeguard and foster land-use measures that will retard stream run-off.

On the basis of taxable assessed values, Catchment Boards may apportion the assessments among the councils[4] of the several counties and county boroughs that lie within a catchment area, and may further assess and require each internal drainage board to make toward the expenses of a Catchment Board such contributions as the Board may consider to be fair. In instances of disagreement as to the justice of the amounts assessed by the Board, the internal districts and councils may appeal to the Minister, who may call a local inquiry and issue an order as he thinks just. When the Minister makes such an order he lays and sets forth the reasons for his order. Compliance with any order made by the Minister for these purposes may be confirmed by mandamus.

Besides such precepted funds, Exchequer Grants may be made, as voted by Parliament, to finance improvement works for alleviation of unemployment and to advance improvement of water control more rapidly than is provided from local assessments. Such grants have been made on a conditional basis, to be matched by stipulated percentage contributions by Catchment Boards. In 1928 the Ministry was authorized to make grants of 50 percent of the net cost of projects of improvement or 75 percent of the wages cost of projects. This authority was extended to the Catchment Boards in 1930, was withdrawn in 1931, and again made available in 1935. Under this arrangement urgent comprehensive works have been undertaken. Such provisions are reminiscent of our P. W. A. grants.

The Catchment Board is required to prepare a set of byelaws for the administration of water control

[4] County Councils correspond to boards of county commissioners in the United States and county borough councils to municipal councils.

within its catchment area; these must be approved by the Minister before becoming effective. The Minister may confirm or modify the byelaws submitted, on the basis of protests or of governmental policy, in which case a full statement and reasons for such action are laid before Parliament.

The byelaws of one of the larger Catchment Boards, the Great Ouse of Eastern England, draining into "The Wash" may be cited. Apart from regulations governing the manipulation of weirs, locks, and similar works affecting water levels in the river, certain regulations have special interest in connection with soil conservation districts of the United States:

Sec. 4. "No person shall divert or alter the level of or direction of the flow of water in, into, or out of the 'river' without previous consent in writing of the drainage system of the catchment areas . . .

Sec. 6. "No person shall discharge or put or cause or knowingly suffer to be put or discharged or to flow into the river any gravel, stones, earth, mud, ashes, dirt, soil, rubbish, or any other matter of any kind whatsoever whether solid or liquid so as to tend directly or in combination with any acts of the same or any other person to obstruct the flow of water in, into, or out of the river."

Under this byelaw a farmer may be required to stop erosion on his fields when such erosion is delivering erosional debris into the river. Although the authority is not called into use for this purpose in England in the absence of serious soil erosion, yet the principle is established and would apply in the event of appreciable soil movement:

Sec. 9. "The occupier of land through which a water course flows or of land-abutting any water course or the person having control of any water course shall upon being required by the Board by notice in writing within such reasonable time as may be therein specified cut all trees, willows, shrubs, weeds, grasses, reeds, rushes, or other vegetable growths growing in or into the water course and shall remove the same from the water course immediately after the cutting thereof,—provided that this byelaw shall not apply to the main river . . .

Sec. 11. "All persons using or causing or knowingly suffering to be used any bank of the river for the purpose of grazing or keeping any animal thereon shall take such steps as are necessary and reasonably practicable to prevent the bank of the river from being damaged by such use; provided that nothing in this byelaw shall be deemed to affect or prevent the use for the purpose of enabling stock to drink at any place to be made or constructed as may be approved by the Board . . .

Sec. 31. "Every person who acts in controvention of or fails to comply with any of the foregoing byelaws shall be liable on summary conviction in respect of each offense to a fine not exceeding twenty pounds [$100] and a further fine not exceeding five pounds for every day on which the offense is committed or continued."

Special attention is called to this continuing fine which according to reports brings about prompt compliance with actions of the summary or local courts.

Under the operations of the Land Drainage Act of 1930 the Minister of Agriculture and Fisheries has constituted 55 official catchment areas in England and Wales comprising the total land area, and has appointed members and approved their respective Catchment Boards. Byelaws of 27 Catchment Boards have been approved to date (1938). Grants in aid have been made to Boards on approved comprehensive improvement works involving up to March 1937 more than 4 millions of dollars.

The working of the law is bringing system out of confusion; the Act is regarded as a very important advance in regulation for the public interest of water control and land utilization affecting water control. The Minister of Agriculture and Fisheries, the Honorable W. S. Morrison, is pleased with the Act and with its operation, and expects that more inclusive authority affecting water resources, such as fisheries and navigation, may in time be assigned to Catchment Boards. Control of waters on a catchment-area basis has proved to be a solution to the problem of coordinating and simplifying authorities and regulations in water utilization and control.

In short, the Act of 1930 places upon the Ministry of Agriculture certain important authorities and functions such as the following: Creation of new and the amalgamation of existing catchment areas; the constitution of Catchment Boards and the appointment of some of its members; the confirmation of schemes submitted by Catchment Boards for the reorganization of their internal drainage districts; the preparation of maps of catchment areas and determination of the extent of the "main river"; the transfer of the functions of Internal Drainage Boards to Catchment Boards; the constitution of drainage districts outside catchment areas; the decision of appeals lodged by councils or internal drainage boards with regards to contributions from or to a Catchment Board; the confirmation of orders made by drainage boards for differential rating

or exemption from rating; sanctions for loans, and for the confirmation of byelaws.

The power of initiative of the Minister is limited under the Act. The Minister cannot require a Catchment Board to submit any particular scheme or project; he can only confirm, with or without modifications, or withhold confirmation from a scheme which has already been submitted. But under the Act he may require that schemes be presented and approved as a condition of grants by Parliament for improvement works by Catchment Boards.

Conservationists in the United States will follow the working of this development in England with interest.

OUR DRAINAGE PROBLEMS

(Continued from p. 182)

construction of smaller projects. The local drainage enterprises have furnished all material required for the work projects except small amounts used for demonstration purposes and the draglines used for most of the work. Altogether they contributed about 50 percent of the excavation costs.

Table 4 gives a summary of the accomplishments of the 36 C. C. C. drainage camps originally established in Ohio, Indiana, Kentucky, Illinois, Iowa, and Missouri from July 1, 1935, to December 31, 1938. The record of camps in other States is about the same.

TABLE 4.—*Accomplishments of the 36 C. C. C. drainage camps in Ohio, Indiana, Kentucky, Illinois, Iowa, and Missouri, July 1, 1935 to Dec. 31, 1938*

Type of work	Total amount	Amount per camp month
Net area benefited ... acres	6, 275, 000	4, 610
Ditches cleared ... miles	5, 907	4. 3
Clearing on ditches ... square yards	182, 698, 000	134, 238
Levees cleared ... miles	440	0. 3
Clearing on levees ... square yards	19, 536, 000	14, 354
Ditches excavated ... miles	3, 328	2. 4
Ditches excavated ... cubic yards	37, 183, 000	27, 320
Levees repaired and rebuilt ... miles	146	0. 1
Embankment constructed on levees ... cubic yards	2, 172, 000	1, 596
Spoil banks leveled ... miles	1, 511	1. 1
Spoil bank leveling ... cubic yards	8, 583, 000	6, 306
Tile lines repaired and rebuilt ... miles	237	0. 2
Structures repaired and rebuilt	3, 542	2. 6
Value of cooperation furnished	$3, 140, 189	$2, 307
Cooperation per acre benefited	$0. 50	....
Estimated commercial value of work	$12, 719, 000	$9, 345
Commercial value per acre benefited	$2. 03	....
Enrollee time utilized ... man days	3, 303, 774	2, 427
C. C. C. camp time expended ... camp months	1, 361	....

The State extension services have cooperated in the location of camps, in the determination of work policies in the various States, and in furnishing advice relative to drainage camp work operations. Many county agents have taken an active interest in the selection of projects and the execution of the work program. This cooperation is considered of the greatest value in administration of the work.

The need for a supplementary erosion-control program in connection with the drainage camp work has been apparent. Much erosion debris, particularly from adjacent hilly lands, fills the ditches. The recent departmental reorganization and transfer of the drainage activities to the Soil Conservation Service will enable a more comprehensive land-use and erosion-control program in future camp activities.

RESEARCH PROBLEMS

(Continued from p. 185)

pose of survey a few of them are pointed out as of interest to the engineer. The whole field of the hydraulics of erosion is practically untouched. Unexplored problems involve such as these: The entrainment or picking up of erosional debris, its movement as bedload or suspension, and sorting and deposition; the energetics of flow causing erosion and its relation to the design and effect of structures; the use of vegetative materials for run-off channel linings; studies of land slides and slips; "mudflows"; the aerodynamics of wind erosion; the erosion problems connected with irrigation; the relationship of snow covers to erosion processes; the control of mountain torrents, etc. There is practically no end to the practical problems which if thought through to their fundamentals and investigated, present an almost unlimited field of service for the agricultural engineer, the agronomist, and the soil technologist.

RUN-OFF STUDIES

(Continued from p. 190)

occurred on W-II. Although 0.88 inch of rain fell within the preceding 24 hours, the July 16, 1939, rain produced a peak of only 0.53 c. f. s. per acre, which is only one-fifth of the March 30, 1938, rate. The maximum rate of run-off resulting from the August 17, 1939, rain was 0.82 c. f. s. per acre, which is about one-third of the March 30, 1938, rate, yet the total amount (4.75 inches) of this rain was more than twice and the intensity for the "time of concentration" was about 70 percent greater than those of the March 30, 1938, rain.

The writers hope that the few examples discussed in this paper will illustrate the type of information being obtained from the run-off studies on demonstration projects and the absolute necessity of complete and careful analyses before the results can be used as a basis for design.

ENGINEERING AND PLANNING

(Continued from p. 169)

and impervious clay was found within 2 feet of the surface except in the drainageway. The best location for the sodded spillway is at the north end of the fill. The pond will be fenced and water piped through the fill to a watering trough below. No treatment of the pasture will be necessary. The woods, Field 7, will be fenced from the pasture and proper management practices will be followed.

A study of the completed plan for the three farms shows that there are engineering problems on all fields except the existing and proposed forested area. Most of the terraces will outlet individually into pastures, and only one short sodded channel will need to be built. The development of a meadow along the drainageway through the Blake and Stewart farms will prevent soil from being washed down on to the Stewart farm and will provide a needed source of hay. The proper location of field roads is a factor that frequently is overlooked. In this case it has been possible to provide access to all parts of the farms without crossing terraces, with the exception of a small area in Field 6 of the Blake farm.

Although it will be necessary to postpone the reconstruction of some of the terraces pending establishment of pasture and meadow cover and the construction of one sodded channel, this will not actually cause any delay in the application of the conservation program on these farms, since there is insufficient power available to complete the work the first year.

For the Blake farm, the first-year program of work may include the following: The development of the meadow, Field 5; the fencing of the woods and construction of the spring collecting basin and stock-watering tank; leveling of old terraces in Field 6 and the construction of new terraces; the building up to adequate size of old terraces in Field 4; and the sodding of the short portion of the highway ditch in front of the farmstead as soon as it has been resectioned.

The first-year work program for the Morris farm may include the leveling of old terraces and construction of new terraces in Field 1, the sodding of the land being retired to pasture, Field 2, and the construction of the farm pond, fencing the woods, and the sodding of the highway ditch along the north boundary line.

The first year's work on the Stewart farm may include these operations: Contour furrowing and sodding of the land being retired to pasture, Field 1; establishment of the meadow, Field 3; leveling old terraces and building the new terraces west of the field road in Field 4 provided the terraces on the Blake farm have been constructed; the excavation and sodding of the outlet channel and flume at the south side of this field; tree and shrub planting in Field 5; construction of the stock pond in the pasture, Field 6; and the fencing of the woods.

This has been a presentation, in as brief a form as possible, of the procedures and major considerations involved in the planning of farms and the development of a work schedule. Thus we see that agricultural engineering is an integral part of all farm planning, and engineering planning is inseparably associated with other planning aspects.

WATER-FACILITIES PROGRAM

(Continued from p. 178)

irrigated from the Sublett reservoir. Fundamentally, the land-use adjustments are improvements in the present practices and farming methods. These modifications involved the incorporation of grass and alfalfa stands to assist in weed control and to increase the quality and palatability of the feed. Pastures will be improved by the inclusion of more palatable, nutritious and early growing species, and grazing will be rotated at proper intervals to maintain weed-free stands of improved carrying capacity. Alfalfa rotations will be shorter to permit the maintenance of high-yielding stands and to sustain fertility and physical structure of the soil.

Grass was found to be desirable in at least 50 percent of the acreage seeded to alfalfa. Dry lands cropped with a grain-fallow system will be placed in a long-time grass rotation, the grass being utilized for seed, hay, or pasture. Contour cultivation, stubble utilization, trashy fallow, and restricted grazing of crop aftermath will be practiced. Grazing lands and pastures will be grazed in accordance with estimated carrying capacities. Necessity requires that the Sublett ranchers comply strictly with the grazing requirements on the Forest Service and Public Domain grazing allotments to ensure permanency of the grazing resources and to lessen the danger of erosion and damage from silting of Sublett reservoir.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

NOTE.—The Soil Conservation Service presents as guest reviewer its distinguished collaborator, Dr. Paul B. Sears. Formerly with the University of Oklahoma, Dr. Sears now heads the botany department of Oberlin College. An able educator, ecologist and writer, Dr. Sears is widely known for his authorship of *Deserts on the March*, *This Is Our World*, and *Life and Environment*.—THE EDITOR.

SOIL CONSERVATION. By H. H. Bennett. New York. 1939.

The campaign to protect and restore our soil is in some respects the most dramatic event in American peacetime history since the winning of the continent. It differs from all great national episodes which have preceded it in the degree and steadfastness with which it utilizes scientific knowledge.

Most great movements of history have their fiery apostles, their practical leaders, and their chroniclers. Seldom are these three functions combined in one individual as Hugh Bennett (a southerner by birth and training) combines them in the campaign to restore the diseased landscape of this great Nation. If the present volume served no other purpose than to bear witness to this notable fact, it would be significant.

There is no need, however, for the book to rest on its symbolic importance. It is, in its own right, one of the most impressive and potentially useful books to issue from an American press in recent years. It consists of 43 chapters occupying almost a thousand pages, carefully indexed, and illustrated by 358 excellent figures, most of them from the files of the Soil Conservation Service which Dr. Bennett heads. The simplicity and clarity of the language, even when dealing with technical matters, is remarkable. The book throughout is marked by straightforward, lucid, frequently arresting exposition.

The theme of soil conservation divides itself naturally into three major divisions: The process of soil destruction; the consequences; and the problem of control. Dr. Bennett's discussion follows this order. In the preface, Dr. Bennett acknowledges his indebtedness to a considerable number of the brilliant scientific workers whom he has gathered about himself in the Soil Conservation Service. Thanks partly to the colabors of these men, many of the chapters represent the finest, best balanced, and most noteworthy discussions of their particular topics that are available anywhere in English in such brief compass. This is true, for example, of the chapters on "Erosion and Civilization," "Climate and Soil Erosion," "Wildlife and Soil Conservation," "Early Efforts Toward Erosion Control," and "Erosion Problems in Foreign Countries." There is also much that is newly assembled in the chapters on the technique of control.

It is hazardous to attempt to formulate a writer's philosophy even after reading such a comprehensive volume as the present. We can be sure, however, that Dr. Bennett regards soil erosion as primarily a human problem; that he believes that the means have been devised for its solution; that permanent agriculture is possible even where the land is highly vulnerable to erosion when people are willing to pay the price of protection. He is unequivocal in his belief that where this price is not paid, civilization disintegrates.

It is also clear that while Dr. Bennett believes the restoration of the soil to be a national problem, calling for a national program, he does not at all believe this has to mean that the Federal Government shall regiment and control. He is explicit in his endorsement of democratic processes of approach to this national program.

Dr. Bennett recognizes education as a prime instrument in securing democratic action. It appears to be his belief that there is no instrument of democratic education superior to the use of demonstration areas. His insistence on this point is worthy of record by those interested in the applications of science, in teaching, and in political life.

Equally important to those interested in the application and teaching of science are other features about the book. It is documented throughout from original sources with all of the care of a monograph. Perhaps, unconsciously too, it represents a new emphasis on the use of science for the common good. Heretofore the dominant note in applying science has been its utility in devising new ways and means to circumvent old consequences. This book is a demonstration of the utility of science as a means of getting our bearings and coming to terms intelligently with nature instead of trying to outwit her.

Dr. Bennett rightly and frequently stresses the need for continuing research. With this point of view anyone who understands science must agree. At the same time he makes it quite clear that we already know enough to make matters far better than they now are. Perhaps without realizing it he is here caught in the dilemma which faces any public servant who would give to the public the benefits of his own scientific knowledge: an unbelievable amount of energy must be spent in obtaining overwhelming proof of many matters already quite clear to the scientist himself. Like the flattery which Disraeli administered to his sovereign with a trowel, scientific evidence must be poured forth upon the voting public in overflowing and often expensive measure in order to get action. This is true even where self-preservation is at stake—as public health authorities well know.

The editorial and manufacturing work on the book is of excellent quality. The actual errors which came to the attention of this reader are very few indeed. On page 897 the famous Maj. John W. Powell is reduced to the rank of lieutenant. If he deserves any posthumous change of status, it is promotion.

Even such a thorough going volume as the one under review must submit to limitations of space and emphasis. So far as the reviewer is concerned, this is apparent in the discussion of insects and of weeds. In both instances the viewpoint of modern ecology, especially as it refers to living communities and the manner of their development, might have been employed to advantage. There is reason to believe, for example, that many insects (and rodents) are more important in accelerating erosion once it is under way because of disturbed natural conditions than they are in producing the initial disturbance. And the relation of weeds to erosion control becomes highly significant when they are viewed as pioneers in plant succession, making way for more permanent, better integrated communities. It is these balanced and integrated communities—as distinct from mere "plant cover"—which are the active agents of soil genesis, to say nothing of stabilization. Their importance in the field of operations, future agronomic, range, and forest practices is vital. For that reason, perhaps, the reviewer regrets to see any lost opportunity to emphasize the ideas of community and community succession.

But this omission is more than offset by Dr. Bennett's frequent and effective emphasis on the indispensable role of vegetation in soil conservation, and the corollary that engineering techniques must take cognizance of this great principle.

The reviewer feels safe in predicting a world-wide reception to this volume.

—PAUL B. SEARS.

U. S. GOVERNMENT PRINTING OFFICE: 1940

Recent Information of Interest to Farmers and Soil Conservationists

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS–37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Survey of Lake Lee Monroe, North Carolina, May 23–June 14, 1938. SCS–SS–34. October 1939. mm.[1]

Hydrologic Studies: Compilation of Rainfall and Run-off from the Watersheds of the North Appalachian Conservation Experiment Station, Zanesville, Ohio, 1933–38. SCS–TP–26. August 1939. mm.[1]

Precipitation in the Muskingum River Basin, September 1939. SCS–TT–23. October 1939. mm.[1]

Publications on Planning for Soil, Water, and Wildlife Conservation, Flood Control, and Land Utilization. SCS–MP–21. August 1939. mm.

Office of Information U. S. Department of Agriculture

The Acidic Properties of Peat and Muck. Technical Bulletin No. 690. Bureau of Plant Industry. October 1939.

Agricultural Statistics, 1939. 60c.[2]

Flow of Water in Irrigation and Similar Canals. Technical Bulletin No. 652. Bureau of Agricultural Engineering. February 1939.

A Land Program for Forest County, Wisconsin: Based on an Analysis of Land Use Problems. Technical Bulletin No. 687. Bureau of Agricultural Economics. September 1939.

Methods and Procedure of Soil Analysis Used in the Division of Soil Chemistry and Physics. Circular No. 139. Bureau of Plant Industry. Revised November 1939.

Native Woody Plants of the United States: Their Erosion-Control and Wildlife Values. Miscellaneous Publication No. 303. Soil Conservation Service. Slightly revised May 1939. $1.50 paper-cover, $1.75 buckram bound.[2]

Planning for a Permanent Agriculture: Including a Summary of the Programs Administered by the Department of Agriculture that Influence the Use of the Land. Miscellaneous Publication 351. Slightly revised December 1939.

Serving Farm People on Many Fronts. 1937 Annual Report of the Extension Service, U. S. Department of Agriculture. 1939.

Silting of Reservoirs. Technical Bulletin No. 524. Soil Conservation Service. Revised August 1939.

Agricultural Experiment Stations

Agricultural Research Serves to Relieve the Tax Burden. Station Bulletin No. 359. Biennial Report 1936–1938 of Agricultural Experiment Station, Corvallis, Oreg. December 1938.

The Effect of Irrigation and Cropping on Desert Soils. Technical Bulletin No. 263. Agricultural Experiment Station, State College, N. Mex. May 1939.

Farm Organization for Beef Cattle Production in Southwestern Minnesota. Technical Bulletin No. 138. Agricultural Experiment Station, St. Paul, Minn. August 1939.

Liming Western Oregon Soils. Station Circular No. 132. Agricultural Experiment Station, Corvallis, Oreg. May 1939.

Nitrogen and Organic Carbon of Soils as Influenced by Cropping Systems and Soil Treatments. Technical Bulletin No. 45. Agricultural Experiment Station, Manhattan, Kans. May 1939.

Reclamation of Saline (Alkali) Soil in the Yakima Valley, Washington. Bulletin No. 376. Agricultural Experiment Station, Pullman, Wash., in cooperation with Bureau of Plant Industry, U. S. Department of Agriculture. July 1939.

The Relationship Between Soil Maintenance and Profitable Farming. Bulletin No. 604. Agricultural Experiment Station, Wooster, Ohio, in cooperation with Soil Conservation Service, Bureau of Agricultural Economics, and Agricultural Adjustment Administration, U. S. Department of Agriculture. June 1939.

Shelby County Soils. Soil Report No. 66. Agricultural Experiment Station, Urbana, Ill. June 1939.

Small Reservoirs for Stock Water and Irrigation. Circular 154. Agricultural Experiment Station, Bozeman, Mont. September 1939.

Soil Management for Potatoes. Special Bulletin No. 299. Agricultural Experiment Station, East Lansing, Mich. June 1939.

Sudan Grass, Millets, and Sorghums in Oregon. Station Bulletin No. 361. Agricultural Experiment Station, Corvallis, Oreg., in cooperation with Bureau of Plant Industry, U. S. Department of Agriculture. March 1939.

Supplemental Irrigation in Missouri. Bulletin No. 410. Agricultural Experiment Station, Columbia, Mo. August 1939.

Type of Farming and Ranching Areas in New Mexico, Part 1. Bulletin No. 261. Agricultural Experiment Station, State College, N. Mex., in cooperation with Bureau of Agricultural Economics, U. S. Department of Agriculture. May 1939.

Miscellaneous

Conserving Soil by Better Land-Use Practices. Extension Bulletin No. 203. Michigan State College, East Lansing, Mich. June 1939.

Economic and Engineering Phases of Flood Control, Water and Soil Conservation, and Protection of Watersheds in Southern California. Santa Maria Valley Water Conservation District, Santa Maria, Calif. August 1939. mm.

Facing Farm Facts: Food for the Family, Feed for the Livestock, Fertility for the Soil. Extension Circular No. 235. University Of North Carolina, Raleigh, N. C. February 1939.

Farm Forestry: Organized Teaching Material. Vocational Division Bulletin No. 196. Office of Education, U. S. Department of the Interior, in cooperation with Forest Service, U. S. Department of Agriculture. 1939.

Irrigating a Prairie Farm Garden. Publication 657. Dominion of Canada, Department of Agriculture, Ottawa, Canada. October 1939.

Plants in Indiana Poisonous and Injurious to Livestock. Extension Bulletin No. 240. Purdue University, Lafayette, Ind. June 1939.

Report of the Committee on Sedimentation, 1938–1939. (Presented at the Annual Meeting of the Division of Geology and Geography, National Research Council, April 29, 1939.) National Research Council, Washington, D. C. September 1939. mm.

Report of the Puerto Rico Experiment Station, 1938. Puerto Rico Experiment Station of the U. S. Department of Agriculture, Mayaguez, Puerto Rico. November 1939.

Two Trends of Great Agricultural Significance. Extension Service Circular No. 306. Extension Service, U. S. Department of Agriculture. June 1939. mm.

White River Land Utilization Project, Martin County, Indiana. Soil Conservation Service, U. S. Department of Agriculture, Dayton, Ohio, in cooperation with Indiana Department of Conservation. September 1939. mm.

Zaleski Land Utilization Project, Vinton County, Ohio, Soil Conservation Service, U. S. Department of Agriculture, Dayton, Ohio, in cooperation with Ohio Division of Forestry. September 1939.

---

[1] Issued for use by Soil Conservation Service staff and cooperating offices only.

[2] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

ENGINEERS UTILIZE AGRONOMIC MATERIALS

The development and maintenance of protected drainageways is a basic requirement for conservation farming. Permanent grass cover usually provides the best protection. Direct transplanting of sod is often advisable where satisfactory results cannot be secured by seeding or other less expensive methods. About 120,000,000 square yards of drainageways have been seeded or sodded in soil conservation work areas.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

"In terms of land utilization . . . we have expanded our thinking and our action from promoting sound land use on individual farms to carrying out improved land-use programs over large areas that include groups of farms and much land that is not, or should not be, used for cultivation . . .

"As a result of the operation of the soil conservation districts, we are in all our work having to think more in terms of large areas and adjustments among communities as well as in terms of the individual farms. As that viewpoint develops, the fundamental unity of the land utilization program with other activities of the Service stands out ever more clearly."

—H. H. BENNETT, in "The Common Bond of Land Use."

FEBRUARY

1940

Contents

Front cover by Adrian Clem

Back cover by Helen Morley

WELLINGTON BRINK
EDITOR

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. Soil Conservation seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

THE COMMON BOND OF LAND USE

By H. H. BENNETT [1]

Land utilization has long been a familiar term to the Soil Conservation Service. Wise use and protection of the land has been the basis of all our conservation efforts. This fact alone indicates the common thread that runs through the soil-conservation program, bringing together the original erosion control work and other lines of endeavor, including the program that has borne the name of "Land Utilization."

For the past year I think that everyone in the Service, from those who started with the old Soil Erosion Service to those who more recently joined forces in the enlarged Service program, has been going through an educational period. The reorganization of the Department, unifying several lines of work under the banner of soil conservation, has forced us to broaden our concepts and understanding of this work. In terms of land utilization, for example, we have expanded our thinking and our action from promoting sound land use on individual farms to carrying out improved land-use programs over large areas that include groups of farms and much land that is not, or should not be, used for cultivation.

This is one of several contributions that the land-utilization program has made to our campaign to develop an agriculture geared to the maintenance and improvement of land resources. The work in submarginal farm areas has also brought to our

[1] CHIEF, SOIL CONSERVATION SERVICE, WASHINGTON, D. C.

204350—40——1

attention many new and significant facts about land use—for example, the tremendous amounts of money that have been wasted in the drainage and improvement of infertile soils, or the fact that in many communities the cost of educating the children of families on poor lands is several times greater than the amount those families pay in taxes.

Of course, the purchase of land is merely a means, not an objective, in the program—just as on a single farm, proper utilization of a purchase area means the assignment of land to its best use by means of a detailed plan of management for the entire area.

In the Great Plains, local stockmen, organized in cooperative grazing associations, are using the lands purchased by the Government, in connection with their own private holdings. The range improvements, such as water supplies and fences, have been put in as an aid for increasing the carrying capacity and usefulness of both public and private grasslands. In other parts of the United States, purchased lands are developed principally for forestry or wildlife. In this work men are being used who need additional sources of income to supplement what their own farms will produce.

The close connection between soil conservation and land utilization was one of the reasons that led to the incorporation of these two activities in one coordinated program. Experience has clearly shown that no one solution will liquidate our national or regional land problems—problems in which the physical condition of the land is intimately influenced by human ownership and use.

Specifically, there are few, if any, areas in which conservation of the land can be achieved only by working on individual farms. Sooner or later, in many farming areas of the United States, we reach the point in erosion-control work beyond which it may not be possible to produce the necessary

results. It may be that some farms, for example, are too small for the type of agriculture that will conserve the soil and at the same time support a family. On the other hand, there may be farms on which so much of the land is classed as unsuited to cultivation that it is rightly termed "submarginal." Here is where the land-utilization approach steps into the picture, providing the means of a more rewarding readjustment of land use as dictated by physical and economic considerations.

On the other hand, experience of the land-utilization projects has proved a similar point. There are few areas of the United States where land use is so completely out of line with the productive character and permanence of the land itself that Federal purchase is the only means of untangling the problem. Recent projects have tended to emphasize the acquisition of land in limited amounts, leaving as much of the area as possible in private hands. The over-all plan then brings together both public and private lands in a pattern of use and management that applies conservation to the entire area.

In the Department's broad land-use program, the Soil Conservation Service is now charged with a tremendous and challenging responsibility. It has an obligation to maintain and protect the soil resources of all the farm lands from which American families are trying to win a living—from the gently sloping lands where erosion is hardly noticeable to the gullied and worn-out tracts of the more rolling, older farming sections, or the lonely clearings in the peat bogs of the Lake States, where misuse of the land has all but rotted away the opportunities for profitable use. One purpose of the reorganization was to consolidate in one agency most of the available weapons for a broad campaign, using all practical measures coordinated as a single implement, in order to establish good land use as the basis for a stable and permanent agriculture.

Obviously, this campaign will not attain its objective within a brief period of time. The progress already made, however, indicates the specific nature of its methods and objectives.

The program that is now being formulated in Greene County, Ga., provides a good illustration of unified effort at work. Here, within a soil-conservation district, we find all the arms of the Service, as well as other branches of the Department, working together, coordinating their efforts. Cooperation with the soil-conservation district for erosion-control work is safeguarding the soils of the land that have not yet been damaged too seriously for cultivation. Rougher lands, on which soil destruction has proceeded to the point where private owners cannot hope to manage the land profitably, are being purchased in selected tracts and developed for forestry, wildlife, and grazing. The development and management of these tracts are being worked out in conjunction with the plans for the improved use of adjoining private lands. These joint activities on the land itself, plus the important attention to social and economic factors provided by the Farm Security Administration and State agencies, frame an understandable picture of how the Department's complete farm program is fitting together.

Essentially the whole program of the Service in Greene County is one of establishing security for the land and the man on the land, reducing the hazards of floods and siltation, and rehabilitating wildlife resources on the farm through improved land use and land management. As a result of the operation of the soil-conservation districts, we are in all our work having to think more in terms of large areas and adjustments among communities as well as in terms of the individual farm. As that viewpoint develops, the fundamental unity of the land-utilization program with other activities of the Service stands out ever more clearly.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 8 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON FEB. • 1940

LAND UTILIZATION AND THE NATIONAL WELFARE

By C. F. CLAYTON [1]

FARMING, or to use a broader term, agriculture, is the principal use of land in rural areas. The business of agriculture, broadly speaking, extends from the farm through various stages in the production process until the finished product reaches the ultimate consumer. In this process, transportation, storage, insurance, speculation, brokerage, credit, manufacturing, advertising, etc., are involved. Efficient organization for the use of land therefore implies, fundamentally, efficient organization of our resources on a national scale. Land use is not only likely to be maladjusted and economically inefficient, but it must necessarily be so if the industrial framework itself is maladjusted. That is a basic and primary factor in the problem of land-use adjustment. In view of this basic relationship of the organization of the farm to the general economy, we may well ask ourselves, waiving the international aspects of the question, whether or not the problems of land-use adjustment are susceptible of local attack. The answer is, of course, that the two problems cannot be divorced. Consequently, geographically considered, the problems of land-use adjustment are local, regional, and national in scope. Land-use problems are integrally related to the general economic and social structure.

A practical approach to problems of land-use adjustment, therefore, immediately raises a number of basic questions: (1) To what extent can helpful adjustments in land use be effected in local areas, independent of correlated regional and national adjustments? (2) To what extent are partial or piecemeal adjustments in land use for local areas worthwhile in themselves, and to what extent may such adjustments be expected to contribute to, facilitate, or effectuate the broader regional and national adjustments that impede effective adjustments in the local economy? (3) To what extent should the costs of land-use adjustments that contribute to the permanence and stability of the local and national economy be borne by the individual, the local group, or the Nation as a whole?

Land-use adjustment programs, when actually applied in a local area or in a region, involve answers to these questions. The complex character and broad scope of the problem may be illustrated by a brief consideration of the relationship of cultural, institutional, and organizational patterns to the formulation of programs of adjustment in land use.

The use of land is associated, to a degree which we often are slow to recognize, with a definite culture pattern. In referring broadly to these cultural relationships we speak, for example, of a pastoral economy, an agricultural economy, or an industrial economy. But within these broader culture patterns there are significant local orientations which are decisive in their influence upon the use of land. These differences are especially pronounced and of special significance in this country, both by reason of its geographic size and by reason of the rapidity of our industrial and social evolution.

The kind and amount of goods and services deemed essential to a satisfactory life by families comprising a community in the southern Appalachians is, in a very real sense, peculiar to these families and to their physical and economic environment. Their ways of thinking, their beliefs, their conventions, their disposition

[1] Chief, economic surveys division, Soil Conservation Service, Washington, D. C.

for energetic action or for physical and mental inertia all significantly condition their economic organization and ways of using or abusing land, and condition likewise their capacity to adjust their culture to fit such adjustments in land use as relationships external to their own local culture might seem to suggest or require. Programs of land-use adjustment that are contrary to the established culture pattern, when applied to such a population group, are almost certain to fail.

If this generalization is correct, then it appears that limitations on land use imposed by divergences in culture patterns are of two types: (1) Local land-use adjustments never can fully satisfy the theoretical conditions of complete economic specialization, division of labor, and that apportionment of the "factors of production" which would yield to each its maximum return among alternative lines of employment. That is to say, the established culture pattern fixes the limit within which land-use adjustments can be effected. The adjustment realized, therefore, must necessarily be partial and approximate, insofar as the local culture pattern differs significantly from the general culture pattern. Ideal adjustments, that is, adjustments which are ideal from the standpoint of the general economy, are further impeded by the fact that these locally divergent culture groups tend to have a high degree of immobility. People do not like to move to an unfamiliar environment. It is a fact of common observation that the so-called isolated groups are most resistant to any process of "uprooting." (2) If, then, the local economy must fit the local culture pattern, it follows that adjustments in land use to fit the national economic pattern will require the development of local culture patterns to fit the economy which, in the national setting, is appropriate for the particular area. This fact has a twofold significance. In the first place, it places stress upon the primary importance of education as a foundation for effective land-use adjustment, particularly in those areas which have become highly stratified in their cultural relationships. These conditions will be most pronounced among the older, more stable population groups. The second significant fact is that land-use adjustment must originate with the local groups immediately affected. It is through a process of adjustment and adaptation of the culture patterns of communities and groups that stability and integration of the national economy must be achieved.

Reference may be made to the Northern Great Plains to point the contrast between a relatively indigenous culture pattern that is characteristic of many communities in the southern Appalachians and a transplanted culture pattern established by the migration of families from eastern areas to the plains country In the eastern agricultural areas, each farm dwelling was situated on the farm. It was natural that these families, when transplanted to the plains country, would establish their family homes on the lands they expected to farm. The law, so far as the Public Domain was concerned, required this, but that is only to say that the legislators who passed the laws were governed by the same cultural backgrounds as the families who migrated to the plains. Considerations of distance from town, distance from the county seat, isolation from neighbors, difficulties of providing school facilities and similar matters were incapable of registering any significant effect on the pattern of settlement. The result is that today we have in the Northern Great Plains a transplanted culture pattern which is unadapted to the economy suited to the plains country.

It was natural, moreover, that the type of farming introduced by settlers in the plains area should be designed to conform to the pattern of culture which the settlers carried with them. It is true that the effort to set up in the semiarid West a system of farming patterned after the farms of the East has been tempered by the pressure of economic forces, but the culture transplanted to the plains still persists as a brake upon effective land-use adjustment. The plains country lends itself generally to the grouping of families into communities where the advantages of community life, access to schools, stores, etc., can be enjoyed by families, while, at the same time, ranching operations can be conducted at a distance from the home.

The errors made in the settlement of the plains country were certainly not those of the settlers alone. They were errors derived from our cultural traditions, and they were embodied in our homestead laws. There is, therefore, a public responsibility involved in the rectification of these errors. That responsibility derives both from the fact that the Federal Government encouraged the settlement of the plains country on a mistaken basis, and from the fact that the adjustments needed will represent a contribution to the conservation of our national resources much more significant than the immediate benefits to individual ranchers or farm operators as derived from improvements in their conditions of living.

Adjustments in the use of land are also conditioned by a wide range of institutional relationships. For example, the tax structure of many of our western States was developed on wholly erroneous ideas as to the productivity of agricultural lands. Lands

suited only to grazing are assessed as cultivated lands. This impedes, and in some instances, makes impossible effective land-use adjustments. It undoubtedly has contributed to the growth of tax delinquency and has undermined the basis of taxation in many western counties. Schools, roads and public facilities have been developed in the framework of the fiscal and economic structure that was erroneously assumed to be appropriate for these areas.

The burden of mortgaged debt, founded upon the same institutional structure, imposes a further limitation upon land-use adjustment. Investments in land were too often based upon purely speculative values. In addition to placing a heavy burden of mortgage debt on settlers who purchased land, these speculative values have caused lands to be held by nonresident owners with the hope of unloading them in years of good rainfall or unusually favorable economic outlook. The complex pattern of land ownership presents an institutional situation of serious consequence to any effort to effect adjustments in land use. These institutional factors tend to fix the current situation, to establish rigidities in the current economic organization, and thus to impede the necessary adjustments. If we are able to profit by experience, we should recognize, therefore, the importance of maintaining a high degree of flexibility in the institutional framework that conditions types of land use. Taxation should rest upon a flexible basis. Land tenure, including land ownership, should permit the maximum degree of flexibility in the adjustment of operating units to changing economic conditions.

There is still a broader aspect of the relation of our institutional structure to adjustments in land use. As has been pointed out, agriculture as an industry extends in a very real sense from the farm to the consumer. Agricultural adjustment involves the formulation and carrying out of policies that are national in their scope and application. Such policies bring the Federal Government into a direct relationship with the individual farm and farmer to a degree never before known, and never before needed, in our history.

As these national programs impinge upon the individual farmer, he finds that normal political processes give no adequate basis for expression of his views and his neighbors' specifically with regard to the application of a particular program to his community and to his farm. Consequently, there is need for an institutional process that will enable individuals and local communities to give direct expression of their views with respect to specific programs of adjustment. Until such an institutional mechanism has become established and is enabled to function, difficulties must necessarily be encountered in integrating national objectives with local needs and conditions.

The organizational pattern of our industrial system must also be taken into account in considering questions of adjustment in the use of land. In its horizontal organization, farming is carried on by numerous individual farm units. Adjustments in the acreage of farms, in the number, combination and proportion of enterprises embraced by a farm unit, and in the labor and capital employed, are involved in the achievement of maximum efficiency in the use of land for farming purposes. But the working out of these adjustments in response to price and cost relationships inevitably encounters limitations: Population does not shift quickly in response to shifts in economic opportunities; division of labor and specialization are much more limited in their application to farming than to numerous other types of industry; land of a specific grade and quality cannot be shifted like a factory or an industrial plant from one point to another; and there are other reasons also for these limitations.

In its vertical organization, agriculture as an industry embraces, in addition to the individual farm business unit, a whole range of business institutions—banks, railroads, warehouse and storage facilities, commodity exchanges, manufacturing and processing plants, manufacturers of agricultural machinery, etc. Any maladjustments in the economic structure, particularly of that portion directly related to the "vertical" organization of the agricultural industry, will, therefore, be directly reflected in the organization of farms. A farm that is economically well organized to fit a maladjusted general economic structure may be poorly organized from the standpoint of maximum national economic efficiency and from the standpoint of conservation and the national welfare. Corrections in the misuse of land may be contingent upon the correction of maladjustments in our general economic organization, directly or indirectly related to the organization of the individual farm.

Conservation of land presents a problem of general economic organization, as well as the problem of individual farm organization. Indeed, considerations of general economic organization are perhaps much more decisive in this regard than considerations of individual farm organization. It is nevertheless true that no significant conservation of agricultural land can be effected except to the degree that this conservation takes place on the individual farm. It is the farmer who chiefly uses the land. It is the farmer who must be depended upon, in the last analysis, to conserve the land.

To what degree can this conservation be effected by cooperation with farmers in local areas, independent of broader adjustments in our national economy? Certainly it is clear that only limited ends can be reached by resting the full responsibility upon the farmer. The adjustments which the individual farmer and farm community can make to meet the requirements of a maladjusted national economy may give to the farmer and the locality the maximum short-run benefits obtainable, and yet be wholly inadequate or even detrimental from the standpoint of long-term conservation. While the private needs of the farmer may often appear to conflict with the social ends of conservation, it must be recognized that the impediments to the socially efficient use of land do not rest upon the individual farm or the individual farmer alone or upon agriculture as an industry alone.

These general considerations suggest that a wise land-utilization program is fundamental to the development of an efficient and stable social and industrial economy. Such a program should be pointed to the conservation of our resources through the efficient use of land, but we should recognize that efficient use of land is a relative term and that a balanced national economy is a necessary prerequisite to socially efficient land use. The efficiency of a "business unit" is a function of private prosperity; the efficiency of land use is a function of national welfare.

MANAGEMENT OF LANDS HELD UNDER TITLE III OF THE BANKHEAD-JONES FARM TENANT ACT—By EDWARD G. GREST [1]

THE lands held under title III of the Bankhead-Jones Farm Tenant Act were largely worn out as a result of abuse and misuse at the time they were purchased by the Federal Government. They were occupied by families who no longer were able to support themselves satisfactorily from the production of the land and, in a great many instances, were dependent for livelihood upon some type of public aid. Many of the families occupying lands within the area and adjoining the area but not proposed for purchase were in similar condition or were approaching it. The problems facing those responsible for carrying out the complete land-adjustment program involved, on the one hand, changing the use of the land to a use to which it was better adapted and, on the other hand, relocation and rehabilitation of families occupying the lands purchased and rehabilitation of families occupying the lands not proposed for purchase but included in the area of adjustment.

The "area of adjustment" is the area within which land-use adjustments may be attained through added opportunities made available to the families through purchase, development, and management of project lands by the Government. Although acquisition of the land, relocation of the families occupying the lands purchased, and development of these lands contribute materially to the carrying out of a land-use adjustment program, the burden of completing the job and making it effective rests on the management program. To accomplish this, the lands in most instances will have to be used to the fullest extent possible, consistent with restoration and conservation of the resources, to provide a better standard of living and a basis for a more stable livelihood for the families living on intervening and adjacent lands.

During the process of planning and developing a project, rather definite determinations are made regarding the future use of the land. It may be assumed that in planning the future use the most intensive use is designated as consistent with restoration and conservation of the land, with the needs of the community, and with the objective of providing a basis for a better standard of living. These uses involve grazing or pasture, forestry, recreation, and wildlife protection and conservation.

In planning a program of management for the grazing or pasture resources of a project, two important factors must be kept in mind. These are (1) restoration of the land and cover at the greatest possible rate and (2) the production needs of farm or ranch operators within the land-use adjustment area to provide livelihood for their families or to remain in business. Often it may be necessary to sacrifice some speed of recovery in order not to disrupt seriously the economy of the area. This is particularly true in range areas that were overstocked, and where the purchase program merely removed crop farmers with very small numbers of livestock. If the range is overstocked, the stockmen should be required to reduce the numbers of livestock so as to permit appreciable improvement under the prevailing conditions. These adjustments must be

[1] Chief, land management division, Soil Conservation Service, Washington, D. C

made in such a way as to cause as little financial inconvenience as possible to the stockmen; reduction to provide for the quickest possible recovery of the range might ruin the operators and do more harm than good. Under certain conditions it is difficult to determine the proper balance between rapid restoration of the range and continued financial stability of the operators. In recent years, as is well known, the reduction of stock numbers during and after periods of continued drought made possible a phenomenal recovery of the range with recurrence of normal rainfall.

A plan of management for the forest area of a project must include its protection from fire and other controllable hazards, and its utilization to provide a continuous income at a rate as constant as possible and commencing as soon as the development program is completed, or prior to that date if the program of development is minor and some of the timber is available for harvest. The idea is to provide supplementary income for occupants of farms in the community who require it for a satisfactory living. A constant source or gradually increasing source of supplementary income from the harvest of forest products will produce a social and economic condition in the area, far superior to intermittent or delayed harvesting of timber resources although the total return might be somewhat greater under the latter procedure. On projects where the welfare of the families in the area of adjustment is dependent upon supplementary income from outside work and none is available except that provided by the project, it would be extremely desirable to have funds available to provide employment and at the same time improve the property. The needs for such funds would gradually decrease as harvesting of forest products on the project increased. The development of such areas at a rather moderate pace and carrying on developments over a period of years is much to be preferred to an intensive program of development to be completed in 3 or 4 years. The former type of development program would not require bringing in labor from outside the adjustment area and would be a means of providing the minimum of supplementary income to the families until the harvesting of forest products is adequate to provide the necessary supplementary income.

Recreational developments have received varying degrees of emphasis in the projects. These developments include picnic areas, bathing and boating facilities, vacation cabins, group camps, and combination buildings commonly referred to as lodges. In many instances artificial lakes have been constructed to provide bases for recreational developments. As a general rule, the nature of such developments on projects was dependent upon the adaptability of the project for such use, demands for such facilities in the area and to some extent upon opinions of the individuals responsible for planning the project. The approach to the problem of management of these facilities is of necessity very different from that of range, pasture, and forest management. The group camping facilities were intended for the use of organizations fostering educational and recreational programs for rural youth groups and also for urban youth groups, insofar as possible.

Considerable attention has been given to improving conditions for wildlife and to restocking some of the areas with indigenous species. The project lands will be managed as wildlife refuges, controlled hunting, or fishing areas, or as areas open to the taking of game or fish in accordance with existing State or Federal laws. The management practices followed will depend upon conditions on the project and surrounding areas.

The land management program should be so planned that restoration of the cover, stabilization of the land and fertility improvement may continue under controlled and proper utilization.

This program of management should not be confined to the lands purchased but should involve proper use and management of privately owned lands within the area of adjustment. We know from experience that considerable effort and time will be required to bring about a satisfactory change in the use and management of the privately owned lands. It will be the duty of technicians to prepare farm or ranch conservation plans. The needs for additional resources in the form of land, livestock, equipment, or employment will have to be determined for each family; an exact determination will have to be made as to the extent to which these needs can be supplied in connection with the use and management of the Government-owned property in the area. Relations between tenant and landlord may need to be improved; and families should be gradually educated to new methods of farming and new ways for making a living.

Not all land-use adjustment projects transferred to title III of the Bankhead-Jones Farm Tenant Act are administered by the Soil Conservation Service. Some are being administered by the Forest Service, others by the Bureau of Biological Survey, and others by State agencies under cooperative agreements. In general, however, those projects involving to a considerable degree adjustments in the farm or ranch organization within and surrounding the project area

204350—40——2

are being administered by the Soil Conservation Service and this includes the larger share of all lands held under title III. In addition, the Soil Conservation Service acts somewhat as landlord to projects administered by State agencies and of the type mentioned above. The Forest Service is administering a number of projects which are largely forest in character and which involve little, if any, adjustment in farm organization, and represents the Federal Government in connection with such projects under administration of State agencies. The Biological Survey has these same responsibilities for projects that are of vital importance to the program of that Bureau.

The question may be raised as to why lands purchased under a Federal program of land-use adjustment should be administered by a State agency. Early in this program it was determined as a policy that some of these lands be made available to appropriate State agencies under long-term agreements. These agencies include State conservation departments, forestry departments, colleges, and universities. It is believed that with State administration of some of the project lands, the interest in land-use adjustments of this type will become broader, that the demonstrational value of projects will be increased, that State departments will establish programs of this type with State funds, and that as a net result of all of these the program will be advanced more rapidly than by Federal effort alone. In addition, it is believed that the administration of these lands will strengthen and tend to stabilize some of the State agencies involved.

Some of the projects in the range area under the jurisdiction of the Soil Conservation Service are being administered through cooperative grazing associations organized under State law. The members of these associations are stockmen eligible to use Government-owned land. The association through its board of directors handles such matters as the leasing of State, county, and privately owned land, issuing grazing permits, collecting fees, control of the range, and maintenance of facilities including water sources, fences, etc. The Soil Conservation Service establishes the grazing fee to be paid the Government by the association, the carrying capacity of all the range used by members of the association, the grazing season, and the criteria to be used in distributing grazing privileges among members of the association. The association leases all land within the area not owned or controlled by stockmen operating in the area. This method of administration is in accordance with the policy of the Department and has proved very successful. It introduces a degree of self-government in the use of the range, it tends to produce a greater interest in the goal to be accomplished and thus a higher degree of cooperation, and it reduces the cost to the Service for administration and maintenance.

The advantages of administering these lands through local organizations will, no doubt, become more and more apparent, and as a result there will be a growing tendency toward making the lands available to local organizations and organizing local associations of one type or another where none exist. At present it is thought that the soil conservation district governing body will prove a desirable local agency through which to administer project lands. Where established, districts will no doubt be given an opportunity to demonstrate the feasibility of this method of administration.

As pointed out earlier in this article, the administration of recreational facilities introduces some special problems. These can be overcome by placing the operation of these facilities in the hands of some local organization or by having them operated by a concessionaire. Under either type of operation, considerable overseeing will be required by the Government, but by exercising proper care in selecting the local organization or concessionaire, there is no particular reason why either method of operation should not be successful.

The problems confronted in connection with the land-management program include the question of charges to be made for use privileges to be granted, the basis upon which use privileges should be distributed between applicants or eligibles for such privileges, and the relocation and/or rehabilitation of families residing on the lands purchased.

In establishing charges for the various privileges to be granted, the aim is to arrive at a rate equal to the value of the privilege. This rate is difficult to determine and, in some instances, experience will be the main guide, while in others studies will have to be made before equitable rates sufficiently flexible to take care of changing conditions can be established. Until such studies are made, rates will have to be established on as equitable a basis as possible by taking into consideration all available information.

Since the resources on any one project usually are limited in comparison to the demand and needs for them, care must be exercised in distributing use privileges. Objectives of the project, needs of the families to be assisted, prior rights of operators in the area, and

(Continued on p. 215)

Portion of a 200-acre slash pine planting, Poinsett land utilization project, at end of third growing season. Growth during the past year—an increase in height which should continue for 15 to 20 years—is indicated by the positions of the hands of the man at the left.

NATURE AGAIN HAS HER WAY ON THE POINSETT PROJECT

By L. J. LEFFELMAN [1]

IF NATURE can be credited with purposeful action, then the evidence of the past two centuries indicates that she never intended the sandhills of Sumter County, S. C., to be other than a wilderness beauty spot adapted primarily for forestry, wildlife, and recreational uses.

Rising above the humid swamps of the Wateree River, the sandhills once were covered with a magnificent growth of longleaf pine. Along the streams and swamps grew red and black and tupelo gum, cypress, red and white oak, and southern white cedar. Wildlife and vegetation flourished in almost tropical abundance.

But if the sandhills lay under some beneficent spell, it was quickly broken by the blighting touch of civilization. The virgin forests were cut without any thought of the future and repeated fires have since taken their toll. When clearings were planted to cotton and corn the land seemed to lose its productive power. Dwarfed scrub oak has taken over many areas once occupied by the giants of the forest.

It was nearly two centuries ago that the first traders came by the road from the backcountry to bring their wares to Manchester Landing, at the head of navigation on the Wateree River. As early as 1800, the taverns and shops of nearby Manchester were well known to travelers by stage along old King's Highway from Charleston to the upcountry.

Twice during the past century a railroad has been built from Sumter to Manchester, only to be abandoned later. For a considerable time cotton from the large plantations along the Wateree River and rice and indigo from the river swamps, made the town an important shipping point. Manchester was listed by Simms in his Geography of South Carolina (1840) as 1 of the 10 largest towns in South Carolina. Today a graveyard overgrown with vines and trees is the only evidence that Manchester ever existed.

This did not come about as the result of any one factor. But with the land stripped of its wealth of

[1] Chief, regional land-management division, Southeastern Region, Soil Conservation Service, Atlanta, Ga.

native forest, ravaged by war, beset by changes in the economy of plantation days, and without industrial resources, Manchester became isolated by new transportation developments and finally vanished from the earth, leaving behind on small unproductive farms only a backwash of its once prosperous population.

Retreating before the strange transformation that had come over the land, deer, wild turkey, and other game had long before sought shelter in the well-nigh inpenetrable haven of the river swamps. Only scattered pines, scrub oak, and abandoned fields were left of the magnificent forest, and only a few white marble slabs of all the gay social life and thriving commerce. Man and Nature alike had abandoned the land to its fate.

This was the scene that the sandhills of Sumter County presented in 1935 when the Poinsett Land Utilization project was established. Although erosion had not been a factor in the plight of the land and its people (the deep sand quickly absorbs even the heaviest rainfall) the unproductive character of the sandy soil and the lack of continuing natural resources made the problem much the same as that of severely eroded areas.

Conditions had reached such a point in 1935 that with few exceptions the 116 families, mostly Negroes, on the approximately 30,000 acres now purchased were living in squalor. Many of the houses were only one-room shacks, some of them with dirt floors. These families, dependent almost entirely upon cotton for a living, received virtually no return for their labor, for in many cases it required 10 acres to produce a single bale. Taxes had long been delinquent on most of the farms, but because the land was unsuitable for agriculture it was useless to attempt to sell the farms to satisfy tax liens.

Recognizing the complex nature of the problem, a group of Sumter County citizens sought to find a solution that would at once relieve the condition of the people, take the submarginal land out of production, and demonstrate a well-balanced land-development program applicable to the extensive sandhills formation that stretches in a southwesterly line along the upper boundary of the Atlantic Coastal Plain at a distance of 40 to 60 miles from the coast. State Forester H. A. Smith actively assisted in working out the problem. Purchase of nearly 30,000 acres of land by the Federal Government, and the initiation of a multiple land-use program in the area was the result.

If the devastation of the sandhills can be attributed to a thwarting of Nature's purpose, then the new trend events have taken has had a very wholesome effect. On land where cotton and corn could not be grown successfully, excellent survival has been obtained with more than 4 million longleaf and slash pines. The 4,000 acres reforested to pines has transformed many of the abandoned fields to waving oceans of green. The seven lakes that have been developed, with a total area of 1,800 acres, are alive with fish from the project's five rearing ponds. Big Bay, the largest of the lakes, has over a thousand acres of open water. Wood duck, once nearly extinct insofar as the sandhills were concerned, are nesting again along the shallow edges of the larger lakes.

A scientific appraisal of the game population has been made by the warden in charge of the wildlife program since the project was taken over by the State Commission of Forestry in January 1939. A quail census in 1935 showed an average of only 1 bird to 25 acres. Four years later, after hunting had been prohibited, fire protection established, and extensive plantings made to provide food and cover for game, another census showed an average of 1 bird to 4 acres. Hunting and fishing are still prohibited, but will be permitted eventually under strict State regulation.

Although a game farm has been operated in connection with the project throughout the development period, the increase in quail on the Poinsett project has been due largely to a natural increase as a result of improved habitat, fire protection, and other measures. Under expert management, virtually all the 6,000 quail produced annually during the past few years have been released on other projects in South Carolina, Georgia, and Alabama.

The two groups of cottages, for white and colored respectively, that have been built around Burnt Gin and Mill Creek Lakes to provide group camping facilities for such organizations as 4-H Clubs and Boy Scouts, were designed to blend with the natural landscape. Only the two water tanks, towering above clumps of pines, indicate that some compromise has been made with the wilderness for the sake of water and sanitation.

Even an old railroad fill, built across a wide depression through which a small stream runs, has been robbed of its sinister implications by closing the culvert provided for the stream and using the fill as a dam. The embankment served as part of the roadbed for the Wilmington & Manchester Railroad, built between 1835 and 1840, which was the nucleus of the Atlantic Coast Line System. This portion of the road was abandoned shortly after the War between the States.

When the project was established in 1935, it was

recognized that the needs of the people themselves and the proper development of the land would require the removal of most of the families from their present locations. The original purchase therefore included a considerable acreage of land with good clay subsoil, such as is found in some scattered sections of the sandhills, to be used for relocating the families. Under revised plans for the project, 1,263 acres of this good land have been transferred to the Farm Security Administration. Plans have been made for the resettlement of 27 selected families on this land as soon as the farm units are developed.

Sixty families have already relocated largely on their own initiative or with the guidance of the project manager and his associates. The success of the relocation of these families may be attributed in large part to the project's active interest in the families and its intimate knowledge of them, their needs, and the existing opportunities in the area. The project manager not only advised individual families of possible opportunities but also personally assisted them in working out detailed arrangements and in securing financial and other assistance needed.

Plans are under consideration for leaving 18 of the remaining 29 families on project lands. These families will be located conveniently to schools, roads, and other public facilities where small areas of land suitable for cultivation will provide a subsistence and perhaps some cash income. The cash income will be supplemented largely by employment afforded in connection with the project. The 11 families for which relocation plans have not worked out are living on lands in process of acquisition or recently acquired with title III funds. These families will be granted temporary use and occupancy agreements pending the development of plans for relocation.

From the inception of the project, State officials were consulted and have closely cooperated with officials of the Federal Government with respect to plans and development work. On April 20, 1939, the project was made available to the State under a cooperative and license agreement providing for the management of the area by the State Commission of Forestry, as a demonstration embodying the principles and objectives of planned multiple land use directed toward the ultimate establishment of a permanent rural industry.

Under this agreement the State assumes the administrative responsibility for the management of the project for an initial period of 50 years, with automatic renewals totaling an additional 45-year period. The agreement outlines the management practices to be followed, which include the application of a forest program on a sustained yield basis, a wildlife program designed to increase the wildlife habitat on the area with provision made for controlled hunting and fishing insofar as a surplus of fish and game are developed, and the operation of existing recreational facilities for the use and benefit of the general public.

Something of the original beauty of the sandhills country is seen in this jungle-like growth along the lower edges of Big Bay, largest of the seven lakes in the Poinsett land-utilization project.

Any income and revenue received from the area is to be used by the State in the management, maintenance, and protection of the project lands. The United States retains title to the lands and maintains a custodial responsibility to assure the management of the project in accordance with the purposes for which it was established. The Secretary of Agriculture has placed the custodial responsibility for this project in the Soil Conservation Service.

The management of the Poinsett project by the State Commission of Forestry, as outlined above, is in accordance with a policy established by the Department of Agriculture in connection with a national conservation program to integrate Federal and State objectives and to supplement the State's program.

READJUSTMENT OF POPULATION TO LAND RESOURCES IN NORTHERN MONTANA

By H. L. LANTZ [1]

THAT portion of northern Montana lying between the Missouri River and the Canadian line, comprising Blaine, Phillips, and Valley Counties and including an area over twice the size of Connecticut, has become a new frontier. These counties, embracing the Milk River land-use adjustment project of the Soil Conservation Service and the Milk River farms project of the Farm Security Administration, have become the proving ground of a program of adjustment of people to land resources.

Crossing the Missouri from the crowded ranges of central Montana, early cattlemen found an almost unlimited range. Range grass grew knee high on the benchlands. Beaver-dammed creeks and spring coulees spilled their overflow to flood-irrigated rich bottoms where even in the winter stock could "rustle" for feed. The rough badland areas provided shelter and early spring feed, with water available during the long dry season.

Charley Russell, who knew every foot of the country and whose oils and watercolors have captured the very spirit of those first frontier days, wrote in a letter to a friend, "It's all grass upside down now."

The backwash of a financial panic, the empire-building plans of transcontinental railways, and the urge of a new generation to find new lands and new opportunities resulted in this vast public domain being thrown open to homesteading. It is stated that President Theodore Roosevelt recommended that a strip of public domain land a township wide on each side of the Milk River irrigation project be reserved from homesteading as grazing land to supplement the income of the irrigated valley. This sound land-use plan was never adopted because the pressure groups, who believed that a family should make a good living on any 320 acres of dry land, succeeded in having it opened for homesteading.

By this time the big cattle outfits had disappeared and smaller independent ranchers had settled along the creeks and rivers. While utilizing the benches and badlands for summer grazing, they harvested prairie hay, raised feed crops, and developed small irrigation projects. Their irrigation systems followed the plans of the beaver, and early spring floods guaranteed them winter feed. The prairie was still unfenced and neighboring ranchers lived 10 to 30 miles apart.

But overnight this era passed and the country became a frontier for farmers. The sleepy little cow towns awoke to hectic activity. Bewildered citizens struggled to meet the needs of the newcomers. The single dusty street lined with false-fronted general stores, saloons, and livery barns grew to a dozen streets. Little hotels, crowded beyond capacity, laid cots end to end in the corridors. New restaurants, stores, and homes sprang up overnight with the sounds of hammer and saw, the creak of loaded wagons. The prairies were hub-deep in dust stirred by wagonloads of supplies being hauled from town by the "dry-landers." The prairies were checkerboarded with plowed fields and the coyotes retired to distant hilltops to shrill their uneasiness.

Those first few years after the virgin prairie had been plowed, rains came in abundance and at the right time. The good rich soil, undisturbed in the centuries of its mellowing, yielded amazingly. The "dry-landers" harvested bumper crops; machinery dealers and shopkeepers reaped profits, and more and more land seekers came west to seek their fortunes. No one paid any attention to the warnings of old timers that dry years would come.

Then, to the confusion of the newcomers, the rains stopped. Hot winds seared the new grain and year after year the land did not return the seed.

The fact that thousands of acres of northern Montana soil was submarginal for continued cultivation was ignored. The fact that over a period of 70 years, as established by weather records, more dry years than wet years had occurred, was not taken into consideration until thousands of dry-land farmers had failed, abandoned their homesteads and left the country or became subsidized by a Government doling out seed loans, feed loans, summer fallow loans and finally, subsistence loans which tended only to perpetuate the vicious circle.

Recommended practices and crops over a 10- or 12-year period included rodent control, large-scale corn production, summer fallow with dust mulch, summer fallow with cloddy mulch, big team hitches, tractor farming, growing of certified seed, alfalfa planted in rows, potatoes, dairying and poultry

[1] Project manager of the Milk River land-use adjustment project, Soil Conservation Service, and of the Milk River farms project, Farm Security Administration, both with headquarters at Malta, Mont.

raising, and many more. Looking back over this period of confusion and frustration it is easy to see that any number of "little facts," all perhaps valuable in themselves and under proper conditions, were useless as cure-alls. For instance, the growing of dry-land corn—commendable, certainly—was recommended as a solution of the feed-crop failure problem. The only flaw was that often the spring months were so dry that crops did not come up at all and even the gophers were hungry.

The complete and final collapse of the dry-farm era saw the once luxuriantly grassed and plentifully watered country in a state approximating that of a desert. Topsoil blown from barren, plowed fields drifted over fences and buildings. Fences piled high with tumbleweeds collapsed and blew across neglected roads. Ranchers, driven into bankruptcy because their range land had been homesteaded, were unable to keep up their irrigation systems, lost their stock and left the country. The accumulated livestock of the remaining ranchers and farmers, turned out to rustle on abandoned land and public domain, had overgrazed the pasture in the vicinity of range water. Acres of good grass could not be utilized because drought had sapped the natural springs and water holes.

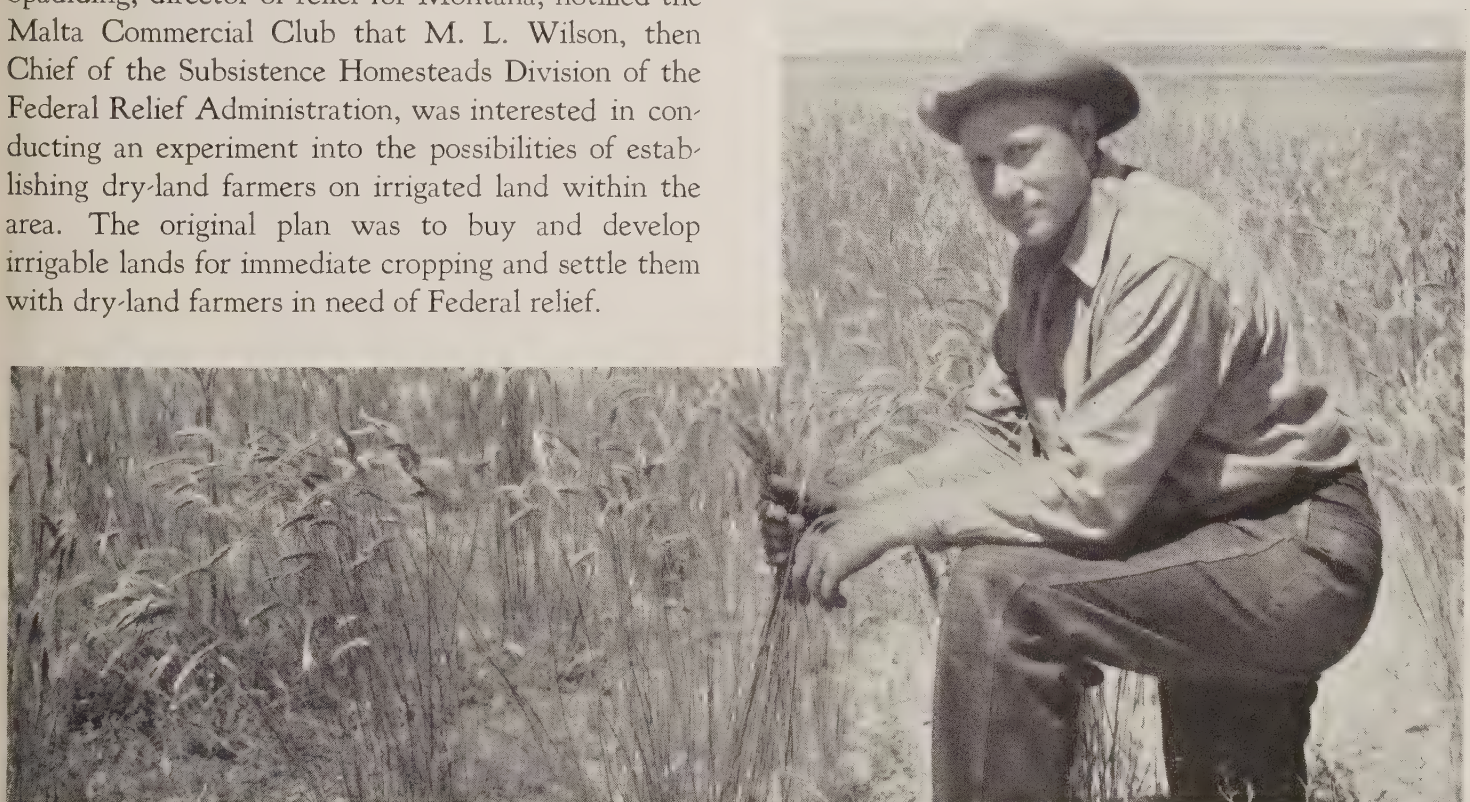
In 1933, the third year of an exceptionally dry period, and a year after the National Red Cross had declared that an emergency existed in northern Montana, T. C. Spaulding, director of relief for Montana, notified the Malta Commercial Club that M. L. Wilson, then Chief of the Subsistence Homesteads Division of the Federal Relief Administration, was interested in conducting an experiment into the possibilities of establishing dry-land farmers on irrigated land within the area. The original plan was to buy and develop irrigable lands for immediate cropping and settle them with dry-land farmers in need of Federal relief.

Out of that move and through the land-use adjustment work already initiated by the Montana Extension Service have grown the Milk River projects and the task, assumed by the Soil Conservation Service and the Farm Security Administration, of changing the agricultural pattern of an area of 7,000,000 acres.

Success of the combined jobs means the return of these millions of acres of submarginal prairies to a planned stock-raising industry and the restriction of farming to the irrigated Milk River Valley, which meanders through the center of the project, or to smaller irrigable tributaries yet to be developed and to a few scattered communities where soil and proper tillage methods are favorable for some types of large-scale, mechanized, grain farming.

The basic fact, upon which both projects are predicated, is that the resources of the three counties are ample for their population. There is land to spare for livestock raising, and the removal of families from these submarginal areas to other States or counties is unnecessary because they and many others can be resettled on irrigable lands in the project area and in the very county in which they have lived.

In the Milk River Valley, the farming population should be concentrated along the creeks and in areas where storage reservoirs may provide irrigation water to be used on the better soil types. Sixty thousand acres of irrigable, undeveloped lands in the area are



This growth of crested wheatgrass, a result of the application of soil and moisture conservation practices, was obtained on purchased land once abandoned as being worthless.

available for the resettlement of from 500 to 600 families. Good homes, modern conveniences, school facilities, roads and opportunities for social growth can be provided. On these developed farm units, sugar beets, corn and potatoes, can be grown for cash crops with alfalfa, small grains and feed crops for wintering range livestock. Supplemented by dairy cattle, garden produce and poultry, these farms will provide good livings for farmers who have gambled and lost for years on the dry land.

The removal of farmers from the submarginal range areas will permit reestablishment of the livestock industry. Sound management of spring, summer, and fall grazing on the uplands, and production of winter feed in the irrigated valleys, should be continued as practices that were successfully followed in the 1890–1910 period. Livestock ranches originally established on such a basis but forced out of business when they lost their ranges are again starting operations with the assurance of summer range, and they are developing the lands to produce more and better winter feed.

The Soil Conservation Service has gone a long way toward readjustment of the population to resources through purchase and retirement of lands unsuitable for cultivation and development of such lands principally for grazing use by farmers and ranchers remaining in the area. During the period extending from the establishment of the submarginal land-use adjustment program to July 1, 1939, submarginal land to the amount of 970,198 acres has been purchased at a total cost of $2,581,800.

The rebuilding of this land has been the means by which many of the families have subsisted during the interim. Scattered over this purchase area 339 stock water reservoirs have been constructed; 59,704 acres have been reseeded to grass, and 35 springs and wells have been cleaned out and improved; 658 farmsteads have been obliterated; 482,000 acres have been covered in a rodent eradication campaign; and cattle guards, highways, terracing and tree planting projects have been completed.

In the project area, 11 cooperative grazing associations have been organized. They operate under the Montana grass conservation law and the Taylor Grazing Act. Public-domain lands and Soil Conservation Service lands are administered by the grazing associations in cooperation with the Division of Grazing. State, county, corporate, and privately owned lands are leased by the associations for the use of their members. Ranchers and farmers remaining in the area are allotted summer range on the basis of commensurate property and prior use and dependency. Farmers located on developed irrigable lands in the Milk River Valley use community grazing pastures blocked out with Soil Conservation Service purchased or other leased lands near their irrigated farms.

The Soil Conservation Service has not devoted itself entirely to the rebuilding of the range but has cooperated with the United States Biological Survey in the conservation of wildlife. Food and cover have been planted in the shallow portions of stock water reservoirs as encouragement to nesting wildfowl. Bass, crappies, perch, sunfish, and catfish have been planted in the larger reservoirs.

Upon the theory that "man cannot live by bread alone," the Soil Conservation Service has developed three recreation centers for the people who live in this once desolate land. From small picnic grounds with a few tables and outdoor fireplaces to a more completely developed recreation site centered around a flowing hot-water well in Phillips County, the area's needs from the standpoint of recreation have been provided. It is estimated that 45,000 people visited these centers the past year.

Of the original 901 families in the submarginal purchase area, 403 have moved by personal choice to other parts of the State or to other States. Other families have adjusted themselves to industries other than agriculture in the towns within the area, and approximately 40 families have been able to purchase farms in the irrigable Milk River Valley with their own resources. With the limited funds provided for the purchase of land and its development, and the construction of homes and farm buildings, 156 of these displaced families have been resettled in the Milk River Valley by the Farm Security Administration.

A recent survey conducted by the Farm Security Administration indicates that 79 families, all of whom sold submarginal land to the government, must still remove from the dry-land area. Forty-four families will be able to locate themselves, nine are problem cases for other agencies to handle, and 26 families should be resettled by the Farm Security Administration.

The program of the Farm Security Administration has complemented that of the Soil Conservation Service by developing lands suitable for cultivation and extending financial assistance and guidance to families living on lands purchased and who are interested in the farm units developed by that Administration. The lands used for this purpose were almost entirely undeveloped before acquisition by the Farm Security Administration. Development consisted of leveling fields, construction of ditches and drains and other irrigation structures, building of roads, houses, and

other farm buildings. The first land was put into production in 1936 when 814.5 acres were farmed. It is estimated that by the spring of 1940, 11,757 acres will be in production.

There are two classes of resettlement clients, those who lease or purchase farm units and those who lease labor units. The farmer client has a unit of from 80 to 160 acres. He raises sugar beets, potatoes, small grains and feed crops, supplementing his farm income with dairy stock, a farm flock of sheep or poultry products. His surplus feed may be utilized by the purchase of feeder lambs or steers in the fall. In some cases he owns range stock. He buys his feeder stock from ranchers in the area and in this way aids in balancing the production picture in northern Montana. He is doing much the same thing as the older generation of stockmen did. He is using irrigable lands to produce feeds to finish the stock raised in the submarginal range areas. But he is doing more for he is getting his living, his few luxuries and a cash income in addition from his irrigated farm. His children are attending good schools. His wife has modern conveniences in her home and the family is interested in building the social structure of the community.

Then there is the second class of client. This class consists of former farmers from submarginal areas who have secured part-time employment, working either for farmers in the community or doing other types of labor. There are 31 family units of this type in the project. These are located adjacent to a town or village. The units vary in size from 1 to 5 acres and provide a garden spot, a feed plot for a cow or pigs, a good house, barn, and poultry house. Here the part-time worker can house his family and make the greater part of the family living from the land. The family is close to good schools and the land has been developed for efficient irrigation and maximum production. A small rental includes house and land. Future farm clients are usually selected from the more aggressive operators of these family labor units.

As an indication of the progress made by farmer clients, it is interesting to note that approximately 5,000 head of sheep and dairy cattle have been purchased in the past year. Farm flocks averaging about 100 head of ewes and the addition of from one to four dairy cows to the farm herd have been made by 95 clients.

Security for old age and for children, happiness in the building of a home and the satisfaction of bringing crops to a harvest should be the rewards of the farmer in any land. It is a big task—this readjustment of population to land resources. But when it is completed every soil type and every farm should be adjusted to its best use, and every community and every family guided toward providing for themselves the best security the resources of the area can furnish for social and economic well-being.

THE LAND PURCHASE AND DEVELOPMENT PROGRAM IN BACA COUNTY, COLO.

By NORMAN G. FULLER [1]

BECAUSE the appalling "black roller" dust storms, which first focused attention on the Dust Bowl, have not raged across southeastern Colorado for more than a year, there is a growing belief that the Dust Bowl has disappeared. It is true that control measures gradually are cutting down on wind erosion. But the Dust Bowl is not far away, lurking under a cover of Russian thistles that will roll away with the first spring winds, or temporarily held in check by sorghum stubble that will hold the soil for 1 year, but probably not for 2 and certainly not for 3. Blowing soil can be stopped, but the fundamental causes of blowing soil present a far more stubborn problem.

In Baca and eastern Las Animas Counties, Colo., there still remain thousands of acres of wild land, without a green spear growing on them. Sand and dust sift eternally across these acres, engulfing fences and roads and creeping into adjacent fields. Abrasive, blowing sand still is cutting the grass from depleted pastures. Soil sifts along only a foot or two above the ground, carried by constant prevailing winds, but it is doing more damage than the "black rollers" did. It merely takes a little longer time, and it makes up in persistence what it lacks in speed.

In Baca County it is significant that the Federal and local agencies now have settled down to a steady, purposeful campaign. After working relatively independently for several years the various agencies recognized that no one agency or group could master the situation alone. They then began to combine their forces in order that each agency would function as an integral part of one large mechanism, capable of coping with the problem. The results of this coordination already can be seen on the land itself.

[1] Project manager, Southern Great Plains Region, Soil Conservation Service, Springfield, Colo.

In the Spring of 1938, this spot was at the center of 10 thousand barren, blowing acres. Farmers and Western Baca District, working together, planted cover crops and reclaimed more than half of this wild area in 1939. The district and the farmers financed the work by loans from the Farm Security Administration, secured by Agricultural Adjustment Administration payments. Broom corn, cane, and Sudan grass here grow lush on a tract purchased by the land utilization project.

Like most High Plains areas, Baca County has gone through the historic cycles of stock raising, homesteading, land boom, collapse of the boom, and land abandonment. Drought and depression added the finishing touches. The farmer who remained on his land found through the dismal years that his worst enemy was his neighbor's land. No matter how hard he worked to protect his own land, the thousands of wild acres around him poured sand and silt upon his holdings, wiping out his crops and pastures.

The tremendous acreage of wild lands in Baca County presented a menace with which remaining farmers could not cope without help. Obviously these wild acres resulted from land misuse, largely the prevalence of cash crop farming. Proper land use can be achieved, therefore, only by a change in the farming economy. Farmers now agree that the best way to make a living is to change from cash crop farming to diversified farming with emphasis on livestock. To run livestock successfully and diversify their farming the operators must have larger units and more grass. One-year leases are customary throughout the area at present and to encourage the establishment of larger units the operators should be assured greater security of tenure on leased lands. Furthermore without long-term leases farmers cannot afford to effect conservation practices necessary to restore the depleted soil and grass resources in the area.

On the other hand, nonresident landowners, who constitute a majority in Baca County, are reluctant to tie their land up with long-term leases. They hope that a bumper year will come along when they can either farm the land themselves and regain part of their losses, or sell it. This situation caused one local farmer to remark, "The worst thing that could happen to this country right now would be three good years."

These points indicate the complexity of the factors entering into the readjustment of the county's farm economy and abandonment of the cash crop basis. Early in 1938, the land-purchase program was inaugurated in the area by the Department of Agriculture, and the western Baca County soil conservation district was formed. Late in the same year the southeast Baca County soil conservation district was organized. These three agencies were designed specifically to deal with the problems of wild lands and they formed the missing parts in the mechanism needed for a unified assault on the county's basic problems. In April 1938, the Federal Government began to take options on tracts of land which, because of poor soil, abandon-

ment, and lack of vegetative cover, were potential hazards to the better farms in the county or failed to bring adequate returns to their owners. To supplement this program the two soil-conservation districts leased and put under control many tracts of wild land which the Government was unable to option as well as many optioned tracts on which title clearance had not progressed sufficiently to permit the Federal Government to spend stabilization funds.

In 1939 the two districts and the land-utilization division planted cover crops on some 40,000 wild acres, with excellent results. During 1940, it is quite probable that the Government will be able to treat all of its optioned acreage, and thus permit the districts to devote their full attention to nonoptioned lands. With the districts and land-utilization project taking care of the worst wild lands, neighboring farmers are leasing the remaining lands and farming them. The districts and individual farmers finance their erosion-control work on these lands with loans from the Farm Security Administration.

The western Baca district includes, roughly, the entire west half of Baca County, totaling about 850,000 acres. The southeastern Baca County soil conservation district includes 370,000 acres, or slightly less than one-fourth of the county.

The Government purchase project area of 1,175,000 acres includes all of the western Baca district, 4 townships on the western side of the southeastern Baca district, and a strip 10 miles wide and 30 miles long extending through eastern Las Animas County. There is no district organization in the Las Animas County portion of the purchase area. Under the purchase program, 240,000 acres were under option on December 15, 1939, at an average cost of $3.25 per acre, including improvements.

Previous to the entrance of the land-utilization division and the districts into the county, the Soil Conservation Service's 25,000-acre demonstration project, established in 1935, had shown what can be done, in this area of low rainfall and high prevailing winds, by proper tillage and use of water-control and retention structures. The C. C. C. camp under its jurisdiction had completed an impressive amount of this control work. The districts and land-utilization division adopted these proved methods in their control work. When the two districts were formed, they entered into agreements with the Soil Conservation Service for technical assistance and power equipment. The Farm Security Administration and the Soil Conservation Servce are working together in the reorganization of farm and ranch units.

From its inception in 1934, the land utilization program in the Great Plains has had one major program and one major objective—the purchase and restoration of the poorer lands in a community to permit reorganization of unit operations. Five years' experience have proved that the program and the objective are sound.

Complete reorganization of a majority of the operating units in the county would be an ideal means of establishing proper land use. Reorganization, however, is not a separate, independent, solution; the real solution must embody the combined objectives of all the various programs. The properly reorganized unit involves stability of tenure through long-term leases, adequate land resources for the specific operation and efficient use of cropland, range, and water facilities. In many localities, an obstacle to unit reorganization has been the relative density of population. There are not sufficient grass resources and good farm land available for all. The land-purchase program is thinning out the population, enabling certain families to sell their holdings and seek new locations, and making additional land available for those who remain.

With possession of the purchased lands, the Government is able to take a hand in the efficient reorganization of surrounding lands, and to guide and encourage proper use of lands in the affected community. Poor lands are always a severe problem to surrounding localities. Through Government purchase and restoration to their best possible use, the submarginal lands in a community become an asset to the adjacent farmers and ranchers.

LAND MANAGEMENT

(Continued from p. 206)

safeguards to prevent abuses must all be taken into consideration in laying down criteria or rules for the distribution of the privileges involved. Each type of project has a different type of problem in this connection, and even in projects of the same type, there are conditions which require some difference in treatment. Without a well-established basis for granting use privileges the objectives of the project might never be attained.

The program of relocating and rehabilitating families has been satisfactorily accomplished where opportunities existed for such relocation. In a limited number of instances opportunities were created for these families through establishment of resettlement projects by the Resettlement Administration or the State

(Continued on p. 220)

FIVE YEARS AFTER LAND UTILIZATION CAME TO BROWN COUNTY, IND.

By MARY H. SANDERS [1]

I STOOD in the doorway of a log cabin that perched on the brow of a hill and I gazed across the valley to the rim of "Bear Wallow." Tree-clad slopes were covered with a mantle of autumnal golds and russets. A distant blue haze blended into a soft October sky. "What a beautiful view!" I exclaimed.

"Yes, but you can't eat it," said the old woman who stood beside me. She had lived all her life in the hills of Brown County, Ind., in this same log cabin.

Later, I thought again of the old woman's remark and it seemed her comment epitomized the history of Brown County. For nature has endowed the county with a wealth of natural beauty but this beauty is only surface deep. The soils on the slopes are thin and poor. The farmer who seeks to derive a living from the hills finds the land produces scanty crops. Only on the farms in the narrow valleys between the hills is the soil rich enough to be really productive.

It was this paradox of scenic wealth and rural poverty which confronted the Federal Government when it initiated its program of land-use adjustment in Brown County. Over a quarter of a century earlier, a group of landscape artists established a colony at Nashville, the county seat and largest town. The colony has grown and prospered. A gallery has been established to exhibit the work of the Brown County painters—a gallery which has attracted visitors from every State in the Union, as well as travellers from many foreign countries. A number of the artists in the colony have established homes and studios here; some remain throughout the year while others come for the blazing fall and verdant spring.

The Hoosier humorist, Kin Hubbard, for many years publicized the rustic life of Brown County through his writings about the homely rural philosopher, Abe Martin, whose daily comments made familiar such community names as Bean Blossom, Gnawbone, Needmore, Bear Wallow, and Weedpatch Hill. In memory of Kin Hubbard, the beautiful lodge of weathered timbers and native stone in the 15,000-acre State park in Brown County has been named for Abe Martin.

Tourists who visit Brown County have become the most lucrative local business. Hotel accomodations are taxed to capacity each week-end from early spring to late fall. Gift shops abound. Pottery, wood carvings, woven baskets, rugs, and dozens of other items find a ready sale. The revenue derived from such handicraft augments many a farm income.

In contrast to the flourishing activity which the tourists have brought to the communities and farms on the State highways is the quiet life on the farms which are located back in the hills on the unimproved roads. Local citizens told me, when I visited the county last fall, that the depression had never really hit the "native" farmers of Brown County because the living standards of the average farmer of that county were so much lower than the depression level. The average annual cash income, they said, is not more than $150.

Estimates vary, however. One farmer living within the land-utilization project claimed that he and his family were able to live on an annual cash income of $24, depending upon barter to meet their other needs. On the other hand, one economic survey of the families living within the project area set the average net cash income for 1934 at $292.

The years from 1890 to 1900 seem to have covered the peak period of population and prosperity for the county. In 1890 the population was 10,308, while in 1899, the banner year for crops, there were harvested 16,238 acres of corn and 11,206 acres of wheat. The natives say that back in those better times the land was rich enough so that the farmers were able to raise sufficient crops to feed their families and their livestock. They cut timber as their cash crop, and from its sale they were able to live comfortably. By 1900 most of the merchantable timber had been cut from the forests and the soil was becoming so depleted that crop returns were small. Families began to move away and most of the young people went to the cities to find work. In 1930 the census reported a total population of 5,168, or approximately one-half the number 40 years before. Of the 5,168 persons residing in the county, 2,216 were under 20 years of age, only 872 were between the ages of 20 and 35, and 2,080 were over 35 years of age.

When the depression began to be felt in the cities and unemployment figures mounted steadily, a back-to-the-land movement started in Indiana, as well as in other agricultural States. In Brown County the

[1] Division of information, Soil Conservation Service, Washington, D. C.

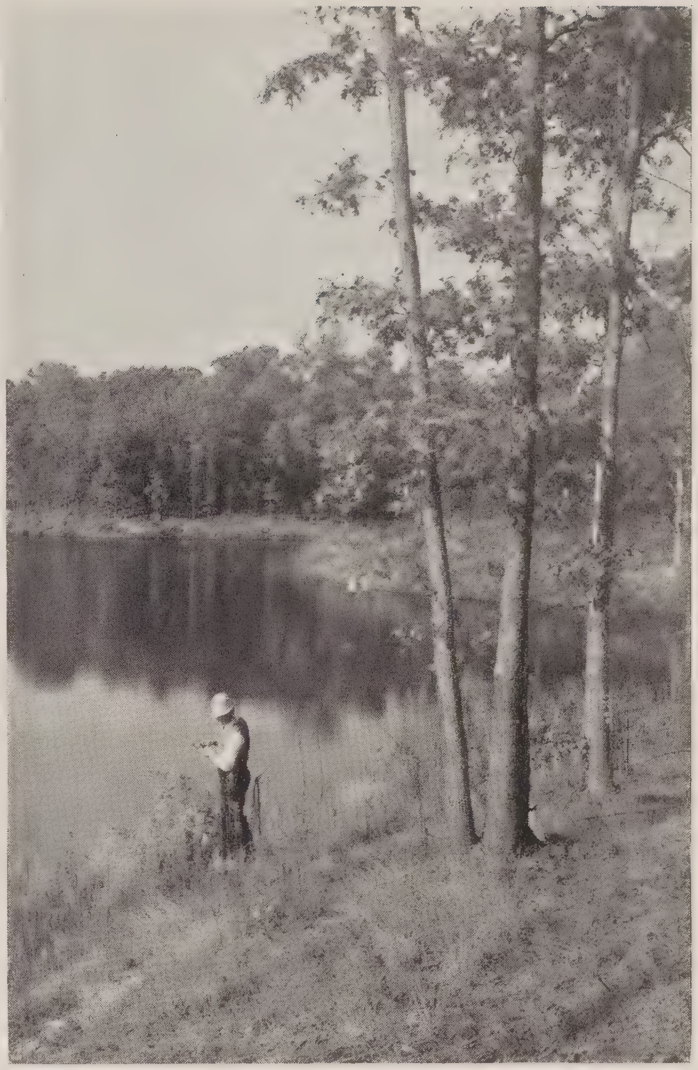
number of farms in operation jumped from 874 in 1930 to 1,204 in 1935, a gain of 38 percent in the number of farms. Although there were 330 more farms on which families were living, only 663 additional acres of land were sowed to crops in 1934 than were in cultivation in 1929. Many of the reoccupied farms were small in size. The new owners or tenants did not have farming equipment, nor were they financially able to purchase machinery or stock for their farms. About 21 percent of the newcomers had no previous farm experience. A survey [2] of this back-to-the-land movement in southern Indiana was made by Purdue University, which determined that in poorer townships such as characterize those portions of Brown County where the Government has purchased land, 36 percent of these newcomers owned their homes, 39 percent were renters, 13 percent lived with relatives, and 12 percent were occupying property without previous arrangement with the property owners. In many instances these newcomers were returning to land which had been abandoned previously because the owners had been unable to make a living on the land.

The amount of poor relief paid by townships affected by this back-to-the-land movement mounted steadily. In 1930 Brown County relief payments had mounted 348 percent above normal and continued to increase each year until the first 5 months of 1934 showed an increase of 1,513 percent.

This back-to-the-land movement was also working a hardship on the school facilities. In Brown County the one-room school house is still common. It was necessary to maintain schools and provide transportation for the children of these newly arrived families. State school aid funds had to be drawn upon heavily. In one locality tax returns are so low that the township would be able to operate only 9¾ days per year if it were dependent solely on its own funds for operation.

This was the situation in Brown County when the Federal Government initiated its land-use adjustment program in 1934. The site of the land buying project was established in the western section of Brown County. Nearly 20,000 acres have been acquired by the Government.

In converting these acres to more suitable land uses, a program of development work has been carried out. The largest single piece of construction is the dam that impounds the waters of beautiful Yellow-Wood Lake. On the shores of the lake there has been developed a camping and recreational area.



A glimpse of Yellow-Wood Lake, Brown County, Ind.

Approximately 33 miles of dirt roads within the project area have been rebuilt and resurfaced with native gravel and sandstone; truck trails have been constructed for firefighting; firebreaks have been built where none of this work had been done before; the forests have been cleared of fallen timbers and brush; 1,609 acres have been devoted to tree plantings and seeding; in addition to the large dam, two smaller impounding dams have been constructed to provide fish and migratory-bird habitats; game shelters have been constructed; Yellow-Wood Lake has been stocked from two fish-rearing ponds on the project. In clearing up the project lands 97 farmsteads and 64 miles of old fences have been obliterated.

All of this work has involved many days of labor—labor which has provided a livelihood for a large portion of the Brown County population. In 1936 and 1937, at the peak of the work, a monthly pay roll of approximately $40,000 was dispensed in the county. Project Manager Walter H. Bowyer has estimated that the pay roll fed about 1,300 persons, including the families of the men employed and representing 25 percent of the county's population.

[2] The Back-To-The-Land Movement in Southern Indiana. Purdue University Agricultural Experiment Station Bulletin 409. 1936.

The school problems have been helped in Brown County as a result of the land-buying program. During this past year two one-room schools near the project were closed because the families had moved from the area. Other schools have been closed during the past 4 years, thus eliminating salaries, maintenance costs, and transportation expenses. The schools have also benefited from a higher income as they received their share of money from delinquent taxes paid at the time title to land was transferred to the Government. The school-fund mortgages have been reduced as these liens against properties were also liquidated when payment was made for the land.

Brown County is in a better financial condition today than it has been for many years. This fact is attested by the county treasurer, Arthur Coffey, who states that he attributes the situation to the sale of land to the Government.

When the land-buying program was getting started back in 1934 and 1935, one of the objections most often heard was that the retirement of land from the tax rolls through its purchase by the Federal Government would create a greater tax burden on the remaining property owners, or deplete the income of the counties affected. Government officials hoped that savings effected by eliminating the maintenance of public facilities, such as schools and roads within the project area, would offset a reduction of income from taxes paid to the county.

While in Brown County I visited the treasurer's office and inspected the tax books; I found that not only is Brown County able to save through a reduction of expenses in maintaining roads in isolated sections and operating schools with small pupil attendance, but there has been an increase in the net value of taxable property and a steady decline in the tax rate during the past 5 years.

In 1934, before any land had been paid for by the Government, the net value of property in the three townships where the Government was acquiring land was set at $1,279,020. In 1939, after more than 19,000 acres had been purchased and withdrawn from the tax rolls, the net value upon which taxes were assessed, was $1,351,910, or an increase of $72,890. This increase of net value of property is largely due to an increased valuation of improvements and personal property on lands which are taxed. Thus, the land-buying program has cleared from the tax books a large portion of the delinquent taxes and has removed permanently from the tax rolls thousands of acres which have a history of continued tax delinquency. Since this burden of uncollected taxes has been removed, the better lands are assessed at a lowered tax rate.

Thus far attention has been directed toward the improvements to the county which have resulted from the land-buying program. What of the people formerly residing on the land?

There were 67 families residing on the lands which have been purchased by the Government, each of which was struggling to eke out a precarious living. Sixty-two of these families have relocated outside of the project area, nearly all of them still residing in the county. The older men and women wished to remain near where they had been born or had lived for most of their lives. Five families of elderly persons remain in the project area, three of them with life leases. Instead of living on roads which were impassable during the winter and spring, the relocated families now live on or near the main highways on surfaced or graveled highways. Many live in better houses, their children have better access to schools.

As previously shown, the lands themselves are being used for economically desirable purposes. Infertile fields are being returned to forest; wildlife is being encouraged to return to the woods and streams. Fishing and hunting will be permitted but will be controlled.

Many local families who have never known such privileges before are now enjoying the pleasures afforded at the beautiful Yellow-Wood Lake Park, for which no admission charge is made. Last year the men who worked on the project planned a picnic and brought their families. Some of the wives said the occasion was the first time they had been beyond their front gates in nearly 3 years.

In summarizing, it can be said that the county government, the businessmen, and some of the farmers of Brown County have profited by the land-buying program. The tourists' and the sportsmen's interest in the county has increased, and, as a result, the businessmen are enjoying better business conditions. The farmers have a better market for their handicraft and produce. Tax rates have declined during the 5-year period. The once magnificent forests are being restored and this source of permanent wealth will again be one of the valuable heritages of Brown County.

Announcement

"The Lost Agriculture of Trans-Jordan"—the fifth of Dr. Lowdermilk's notable series of articles—will appear in the March Soil Conservation.

A submarginal farm in the Hector project area.

LAND-USE ADJUSTMENTS IN SOUTHERN NEW YORK

By JOHN P. JONES [1]

THE Hector land-use project in south-central New York State represents a pioneer effort in the Northeast to develop pastures for community use. The project is intended to serve as a demonstration and it is, to some extent, experimental. It will afford an opportunity to evaluate the benefits derivable from an agricultural adjustment directed toward a more extensive land use assisted by public purchase and improvement.

The project area, covering 43,000 acres in Schuyler and Seneca Counties, is generally typical of large tracts of submarginal land scattered over a 10,000,000-acre problem area in southern New York.

Most of the poor land areas are found in the uplands of the glaciated northern Appalachian and northwestern Appalachian plateau country. Throughout this region, which extends from southwestern New York to the Hudson River and down into the first tier of Pennsylvania counties, the plateau has been cut by many streams, often to depths of 600 to 900 feet and leaving long, flat top ridges supported by narrow valleys, with the valley slopes usually quite steep.

In this area of 10 million acres, including both upland and valley lands, more than 4 million acres are classified by the New York State College of Agriculture as submarginal land. More than 2 million acres are in land class 1, which takes in areas largely wooded or idle. Nearly 2 million acres are in class 2, which includes those areas better adapted to forestry and recreation than to agriculture, but in which considerable farming is done.

[1] Regional conservator, Northeastern Region, Soil Conservation Service, Upper Darby, Pa.

Despite the fact that abandonment has taken place over a long period, and that around a million acres of land have been abandoned for farming since 1900, approximately 78 percent of the area is still in farms.

The important causes of farm abandonment and present land-use problems in these two submarginal land classes of the uplands may be summarized as follows: (1) Exhausted timber supply; (2) low crop yields due to poor soils; (3) continued production of grains and intertilled crops on lands better adapted to forestry and grazing; (4) loss of markets for timothy hay and grain; (5) use of available private and Federal credit to maintain a poorly adapted type of farming; (6) comparatively high cost of public services in relation to the income producing power of the land; (7) soil losses on cultivated slopes, due to erosion; and (8) inaccessibility, poor roads, and inadequate public services.

The most serious erosion problem is on shallow upland soils where cultivated crops are grown on excessively steep slopes. On such soils and slopes sheet erosion has removed much of the topsoil.

In the poorer upland areas, roads, schools, and farm and home conveniences are far below the average for the State. Only 15 percent of the occupied farms and 36 percent of all rural residences in land classes 1 and 2 are on hard roads. Farms in these land classifications are almost entirely without electric service. Only 18 percent of the farms and 14 percent of all rural residences have telephones. Educational services are both inadequate and expensive. In school districts entirely on class 1 land, the average current expense per pupil is approximately $151, as compared with $82 in districts where less than one-half the

land is submarginal. The State furnishes the bulk of funds for roads and schools in these submarginal land sections.

Surveys made throughout the problem area by both State and Federal agencies indicate that the major improvements outlined below would facilitate better land utilization, and that most of them should be initiated at public expense:

1. *Forests and forest land.*—Potential forest areas should be planted. Provision should be made for adequate protection against fire and grazing. Stand improvement work should be carried out in certain areas where undesirable trees tend to inhibit the growth of valuable species. Facilities for harvesting and treating forest products should be established.

2. *Pastures and Meadows.*—Potential grazing areas should be fenced. Adequate water facilities should be developed in each pasture. Lime and fertilizer treatments should be applied where necessary. Barren or idle lands should be seeded to pasture species; and brush removed from lands to remain in pasture. Proper additional erosion- and flood-control measures should be established. Potential meadow lands should be limed and fertilized and meadows not now supporting good stands of forage plants should be seeded.

Since the Hector project area is typical of a large part of the entire problem area, the Service is carrying on three major lines of development—pasture, meadow, and forest—with special emphasis on utilization of land for public pasture and meadow purposes.

It is believed that a large part of the approximately 1,300,000 acres of submarginal land now either in pasture or in cultivated crops, over the whole problem area, can be developed into good grazing land, and that some of the 500,000 or so acres of idle land probably will produce economical pasture if properly treated.

In general, the proposed changes in land use within the project area are the same as those which appear desirable for the problem area as a whole. The change will be from the prevailing combinations of dairy, hay and cash grain farming to the more extensive agriculture which will utilize the better areas of class 1 and class 2 land for community pasture and meadows, and the poor areas for woodlands. According to present plans the area acquired and to be acquired may ultimately contain 5,000 to 8,000 acres of grazing land, 1,000 acres of meadow land, and 7,000 acres of scattered woodlands.

The United States had already purchased under an earlier phase of the land-utilization program, 6,000 acres within the Hector area prior to January 1, 1939. The project plan calls for acquisition, over a 4-year period, of an additional 10,000 acres, of which 6,000 acres were optioned as of January 1, 1940.

Seventy-eight families have been involved in the acquisition of this land. Fifty-five families already have moved from the area; most of them required little or no assistance in relocating after receiving payment for their submarginal holdings.

It is expected that the project will be administered by Cornell University by agreement with the Secretary of Agriculture, and that a cooperative association of farmers and livestock men will operate the project.

It seems reasonable to expect that, with the completion of the acquisition and development programs, the families left within the project boundaries will be self-supporting. Probably also, a considerable number of families living nearby will be materially benefited from the use of pasture, hay, and wood from the area. Actual income always will be low, but the land should produce sufficient revenue, from pasture and meadow service fees and sale of forest products, to make it self-sustaining eventually.

The results of this demonstration in community land use undoubtedly will influence the recommendations of all agencies concerned with the future use of millions of acres of this type of land.

LAND MANAGEMENT

(Continued from p. 215)

rural rehabilitation corporation. In other areas farms were available for rent or purchase and with the cooperation of the Farm Security Administration the status of many of the families was materially improved. Where a continual effort was made by the representatives of the Soil Conservation Service, the Farm Security Administration, and local welfare agencies, other things being equal, a much better job was done; and where opportunities for new locations existed these continued efforts brought good results and the job of relocation was satisfactorily completed. On the other hand, where opportunities were few the job now is only partially complete; many of those relocated were not satisfactorily rehabilitated, and a considerable number of the families still remain on the projects.

In summary it may be well to reemphasize that the management of lands held under title III involves not only utilization of these lands to the maximum, consistent with conservation of basic resources, to improve the welfare of families with inadequate incomes who occupy surrounding lands, but involves also an energetic effort to encourage proper utilization of the privately owned lands of the areas.

U. S. GOVERNMENT PRINTING OFFICE: 1940

Several Annual Reports of Bureaus Included in New List of Bulletins

For REFERENCE

Compiled by Mrs. ETTA. G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Hydrologic Studies: Compilation of Rainfall and Run-off from the Watersheds of the Upper Mississippi Valley Conservation Experiment Station, La Crosse, Wisconsin, 1932–38. SCS-TP-29. November 1939. mm.[1]

Instructions for the Installation of Rainfall Measuring Stations. Technical Instruction No. 1, Hydrologic Division. September 1939. mm.[1]

Seed Propagation of Trees, Shrubs, and Forbs for Conservation Planting. SCS-TP-27. September 1939.[1]

Office of Information U. S. Department of Agriculture

Alfalfa Experiments at Stoneville, Miss., 1935–37. Technical Bulletin No. 701. Bureau of Plant Industry. November 1939.

Community Forests. Forest Service. 1939.

Erosion Losses from a 3-day California Storm. Soil Conservation Service. 1939.

The Farm Outlook for 1940. Miscellaneous Publication No. 379. Bureau of Agricultural Economics. 1939.

Growing Buckwheat. Farmers' Bulletin No. 1835. Bureau of Plant Industry. November 1939.

Mulching to Establish Vegetation on Eroded Areas of the Southeast. Leaflet No. 190. Soil Conservation Service. December 1939.

Report of the Chief of the Bureau of Biological Survey, 1939. 15¢.[2]

Report of the Chief of the Office of Experiment Stations, 1939. 5¢.[2]

Report of the Chief of the Soil Conservation Service, 1939. 15¢.[2]

Report of the Chief of the Weather Bureau, 1939. 5¢.[2]

Report of the Secretary of Agriculture, 1939. 20¢.[2]

Saving Soil With Sod in the Ohio Valley Region. Farmers' Bulletin No. 1836. Soil Conservation Service. December 1939.

Agricultural Experiment Stations

The Drought Farmer Adjusts to the West. Series in Rural Population, No. 4. Bulletin No. 378. Agricultural Experiment Station, Pullman, Wash., in cooperation with Federal Works Progress Administration and National Youth Administration. July 1939.

Fertilizer and Liming Practices Recommended for South Carolina. Circular No. 60. Agricultural Experiment Station, Clemson, S. C. October 1939.

Important Grasses and Other Common Plants on Montana Ranges: Description, Distribution, and Relative Value. Bulletin No. 375. Agricultural Experiment Station, Bozeman, Mont., in cooperation with Bureau of Plant Industry, U. S. Department of Agriculture. November 1939.

Land Utilization in New Jersey: A Land Development Scheme in the New Jersey Pine Area. Bulletin No. 665. Agricultural Experiment Station, New Brunswick, N. J. July 1939.

[1] Issued for use by Soil Conservation Service staff and cooperating offices only.

[2] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Miscellaneous

Effect of Soil Conservation Practices on Farm Labor. Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture, in cooperation with Wisconsin Agricultural Experiment Station. May 1939. mm.

The Farm Orchard. Extension Service Bulletin 89. Extension Service, Clemson, S. C. Revised September 1939.

Feed Consumed by Livestock: A Guide for Planning the Farm Organization. Extension Bulletin No. 203. Ohio State University, Columbus, Ohio. January 1940.

Food, Feed, and Southern Farms: A Study of Production in Relation to Farm Needs in the South. Farm Management Report No. 1. Bureau of Agricultural Economics, U. S. Department of Agriculture. November 1939. mm.

Fourth Annual Report of the Farm Management Service for Farmers in Soil Conservation Demonstration Areas for the year 1938. Minnesota Agricultural Experiment Station in cooperation with Bureau of Agricultural Economics and Soil Conservation Service, U. S. Department of Agriculture. March 1939. mm.

Hands To Save The Soil. National Edition. Civilian Conservation Corps in collaboration with Soil Conservation Service, 1939.

Population Trends in Relation to Land Use. Circular No. 311. Extension Service, Washington, D. C. June 1939. mm.

A Preliminary Report of Data Secured in 1938 on the Farm Accounting Route in Winona County, Minnesota. Minnesota Agricultural Experiment Station in cooperation with Soil Conservation Service, U. S. Department of Agriculture. June 1939. mm.

A Preliminary Study of Farming and of the Soil Conservation Program in the Deer-Bear Creek Demonstration Area, Fillmore and Mower Counties, Minnesota. Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture, in cooperation with Minnesota Agricultural Experiment Station. June 1939. mm.

Proper Land Use Eliminates "Submarginal" Land. Extension Circular No. 410. University of Arkansas, Fayetteville, Ark. June 1938.

Report of the Chief of the Bureau of Public Roads, 1939. (Now Public Roads Administration, Federal Works Agency.)

Soil Erosion in Minnesota. Extension Pamphlet No. 58. University of Minnesota, St. Paul, Minn. March 1939.

Soils: An Elementary Treatise. Circular No. 54, 5th Edition, Revised. University of Kentucky, Lexington, Ky. June 1939.

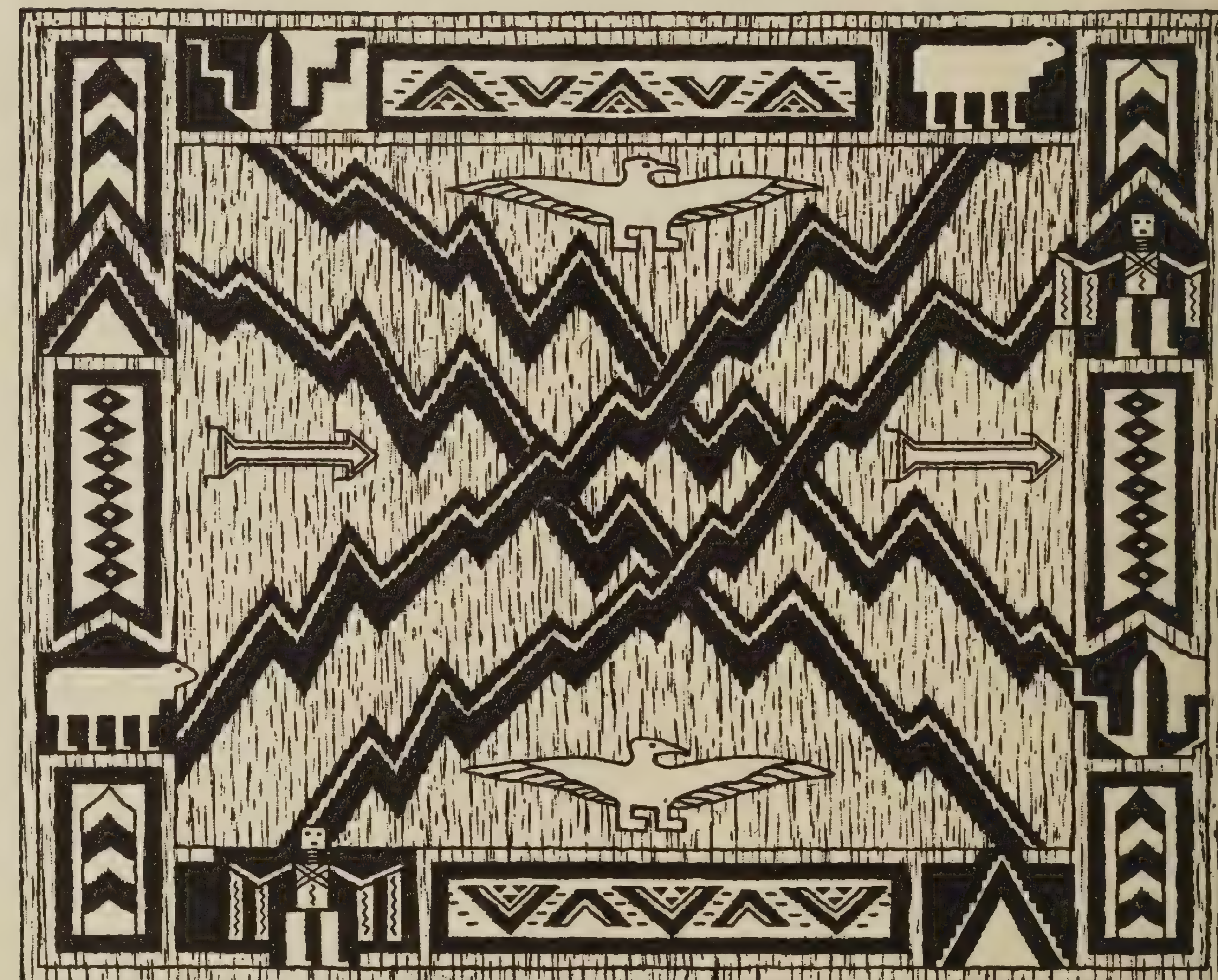
Some Economic Implications of a Soil Conservation Program in Wisconsin. Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture, in cooperation with Wisconsin Agricultural Experiment Station. June 1939. mm.

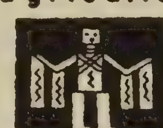
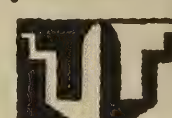
A Study of Economic Data Related to Soil Conservation in Albemarle County, Virginia. Virginia Agricultural Experiment Station in cooperation with Soil Conservation Service, U. S. Department of Agriculture. March 1939. mm.

A Study of Reported Crop Yields in Southeastern Minnesota. Report No. 112. Minnesota Agricultural Experiment Station in cooperation with Bureau of Agricultural Economics and Soil Conservation Service, U. S. Department of Agriculture. June 1939. mm.

Summary of Farm Business and Farm Labor Used, Cedar Creek Soil Conservation Project Area, Franklin County, North Carolina. North Carolina Agricultural Experiment Station in cooperation with Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. October 1939. mm.

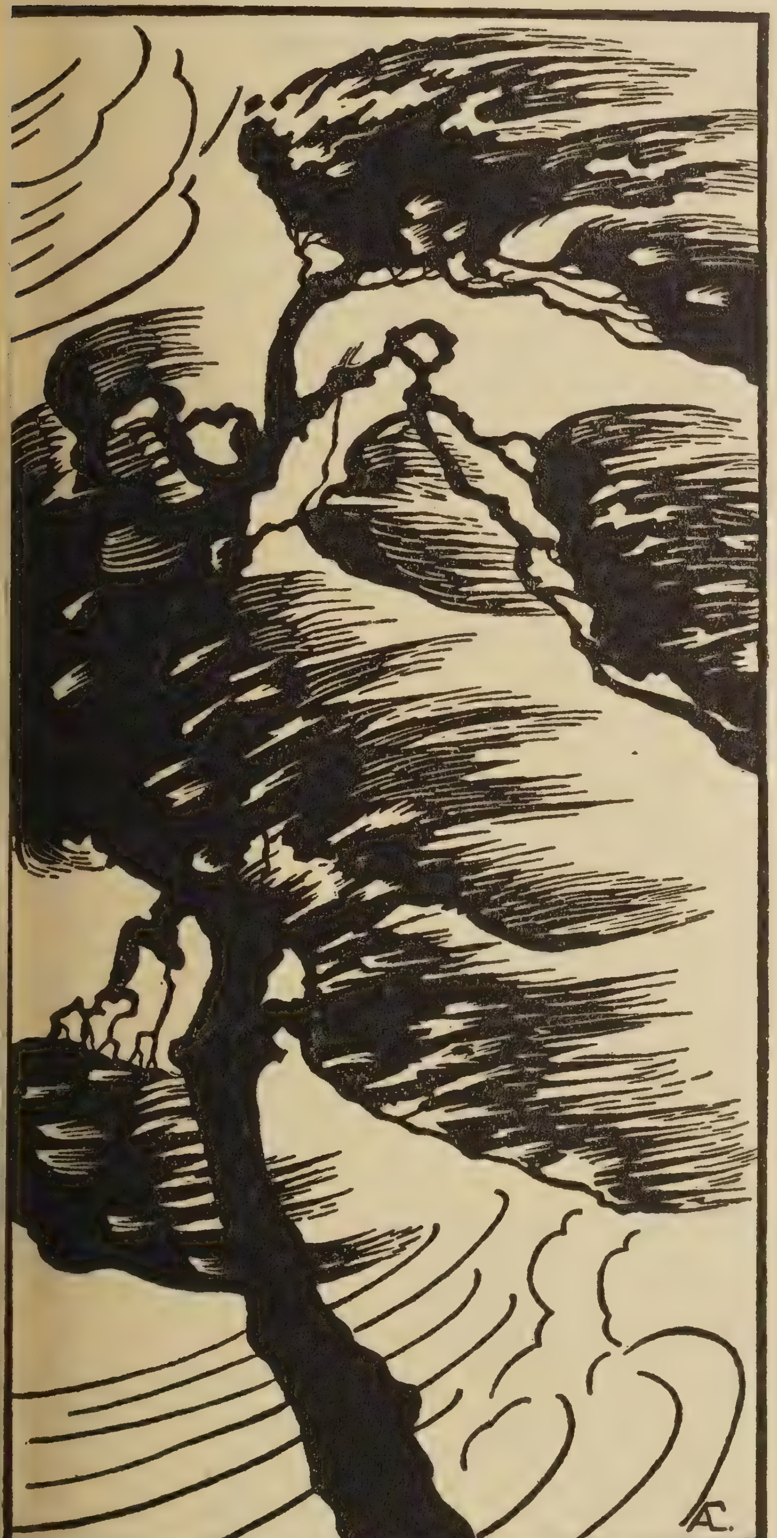
ECONOMIST'S DESIGN FOR A NAVAJO RUG



Here is a new kind of Navajo rug. The pattern constitutes a graph significant in the study of Western land utilization. Interwoven in close relationship are agricultural practices and social welfare. As the number of  Navajos on the land and  sheep on the range increases, the  fertility of the soil decreases and the  plane of living comes down.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON



A good crop stubble will compensate at least to some extent for the loss of the excellent cover of native grasses which was found in such abundance when the pioneers moved into the Plains region, observes V. H. Florell in an article beginning on page 223 of this issue.

Farmers know that certain fields may have water standing on them for several days following a rain, while other fields take up the rainfall rapidly. G. W. Musgrave, in his paper beginning on page 232, discusses important studies being made of the infiltration problem.

M. B. Johnson, in his description of land-use adjustment in North Dakota, tells how the cropping of low-grade farm land, together with a series of dry years, resulted in crop failures and led to a consideration of alternative land uses. The dual objective was to conserve soil resources and stabilize farm incomes. See page 221.

Also, W. C. Lowdermilk, Frank B. Harper; a review of the Annual Report of the Soil Conservation Service; a new list of references.

MARCH
1940

Contents

Front cover by Adrian Clem

Back cover by Harry Nussbaum

Pictorial layout, page 236, by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 9 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON MARCH • 1940

Cattle and horses being driven toward corrals during round-up of McKenzie County Grazing Association.

LAND-USE ADJUSTMENT IN NORTH DAKOTA

By M. B. JOHNSON [1]

LAND-USE adjustment in North Dakota is one of the most popular subjects of discussion at farmers' and extension workers' meetings. Cropping of low-grade farm land, together with a series of dry years, resulting in a number of crop failures over a large section of the State, has caused farmers and Government officials to consider alternative land uses in the attempt to conserve soil resources and stabilize incomes of operators.

One of the best examples of land-use adjustment in North Dakota is in the western part of the State, within the Little Missouri land-use adjustment project in McKenzie County. In 1934, the Federal Government, through the land-utilization program now under the Soil Conservation Service, established this project involving a total area of approximately 766,000 acres, of which about 55 percent has been purchased by the Government. These lands are being made available to resident stockmen for grazing use. For several years preceding the initiation of the program, much of the land was tax delinquent and many of the occupants were on relief with no prospects of improvement in their economic condition. Most of the farms and ranches were too small or the soil was too poor to provide a living for operators under the existing system of use, even when rainfall and price conditions were normal. Living standards were necessarily low and proper educational facilities were lacking. Cost of maintaining schools in the area was higher than the districts' ability to pay.

A survey of the area preceding inauguration of the purchase program indicated that the prevailing type of agriculture was unsuitable to this particular section of western North Dakota. Taxes, levied to finance public expenditures including schools and roads, were far greater than the income from the land warranted. As a result, taxes were not paid and local governmental units along with individuals incurred a staggering load of indebtedness.

The problem of land-use adjustments involved: (1)

[1] Project manager, Northern Great Plains Region, Soil Conservation Service, Dickinson, N. D.

Determining the best use of the land which would prevent further soil deterioration, taking into consideration existing soil conditions, climatic factors, and available markets; (2) determining the probable amount of land necessary to support a family under the proposed system of use; (3) designing a program for adjustment of the population to land resources of the area to ensure a continuous and satisfactory income to remaining operators.

The survey further indicated that much of the land under cultivation in the area covered was unsuitable to farming because of poor soil and rough topography, and that this type of land should be permanently retired from cultivation and returned to the production of perennial grasses. The least hazardous of any known type of agricultural production in this area is the production of native grasses that can be converted into beef, mutton, wool, and milk and augmented by a limited amount of cultivated crops on more favorable soils for supplementary stock feed, garden produce, and some specialized cash crops.

The survey also revealed that approximately twice as many families resided in the area as the land resources could reasonably support. Before actual optioning of land was started, it was necessary to determine which of the resident operators had range-livestock experience and inclinations toward that type of farm life with apparent managerial ability. Approximately 55 percent of the operators had these qualifications, and wished to remain on their land. The other 45 percent generally desired to sell and move from their farms. Their holdings were purchased first. Operators who were undecided on what course to take but had some qualifications for success were further consulted and some of them are still living in the area. Ninety percent of the land recommended for purchase was bought or optioned within the first 8 months of actual land-acquisition activities. Of the 241 families who moved from McKenzie County farms, 220 are still in the State, most of them on better farming units than before purchase of their lands.

All operators remaining in the area have benefited through increased returns. They will continue to benefit in a larger measure as their herds are built up to the carrying capacity of the range. By converting the area to range-livestock production, it was found that many acres of grass were too far away from available livestock water supplies to permit uniform grazing of the range. A program of land development was inaugurated in 1935 to correct this deficiency. Under this program, 40 reservoirs have been constructed; 134 springs have been developed and watering tanks installed; 23 wells were drilled, windmills erected, and storage tanks constructed for a permanent water supply; 438 miles of barbed-wire fence have been built; and 3,700 acres of abandoned farm land have been seeded to perennial grasses. A fence has been constructed on the outside boundaries of the area. This fence, supplemented by a number of division fences dividing the area into 14 pastures, is facilitating good land-management practices by confining live-stock within designated areas and preventing trespass of outside stock.

A large number of farm buildings and fences were acquired with the land. As rapidly as land is purchased, buildings and fences are either sold to the highest bidder and removed from the land or are salvaged as part of the development program and sold or used in construction on the project.

Following the establishment of the land-utilization project, a grazing association was organized. Membership is composed of local operators who elect their own officers, fix land-use regulations, and assign grazing privileges to members according to priority, dependency, and commensurate property qualifications. The association leases Federal, State, and county lands for a period of 10 years, and privately owned land for as long a period as feasible.

Certain laws enacted by the 1938 North Dakota legislature should have far-reaching effect in making possible wise land use. These laws make it possible for county- and State-owned lands to be leased for periods up to 10 years. The McKenzie County grazing association can now obtain long-time leases on State- and county-owned land that formerly was leased for 1-year periods only. The rate of stocking, or grazing capacity of the land, is determined by the Government. In leasing Federally owned lands the association agrees to graze land under its control in accordance with the recommended grazing capacity.

Properly managed economic-sized units, a State grazing law that encourages protection of grasses, and cooperation of individual ranchers in instituting conservation practices have resulted in better grasses and higher carrying capacities for livestock. The operators in the area are pleased with the adjustment program. They now have a degree of security of tenure never before experienced under the old system of year-to-year leases. If future studies definitely indicate that such an increase will not damage grasses, it is expected that, with range improvement, the carrying capacity which is now limited to one animal unit for each 25 acres 10 months per year, will soon be increased.

(Continued on p. 226)

HIGH CROP-STUBBLE AND SNOW CONSERVATION

By V. H. FLORELL [1]

PROBABLY none of the conservation practices used in the Great Plains region will be more productive of results than those designed to conserve moisture. If moisture is conserved, crop production is more certain, and the production of vegetation results in protection of the soil from erosion. The practices, contour farming, contour strip cropping and pasture contour furrowing, are designed primarily to conserve precipitation run-off. These practices, however, will not exert the maximum effect in moisture conservation from snowfall, a source of considerable importance, without proper maintenance during winter of a reasonably large amount of crop residue for holding snow on the land.

The northern Great Plains are favored by fairly high average snowfall, but in common with other portions of the Plains region they are subject to strong winds, frequently of high velocity. Most of the snow storms are associated with high winds, so that a great deal of drifting occurs. Snow that might be held on the fields and pastures now commonly is blown on to roads and highways, making them impassable for traffic. A slight alteration in agricultural practice in handling cultivated crops would do much toward conserving the snow by holding it on the fields where it will be useful.

To give a more definite understanding of the possibilities for snow moisture conservation, average data on precipitation, including snowfall and wind velocities, are presented and discussed in this article. Averages for the following localities were obtained from data reported in the United States Weather Bureau Climatic Summary for 1930: Havre and Miles City in Montana; Bismarck, Devils Lake, Ellendale, and Williston in North Dakota; Huron, Pierre, and Rapid City in South Dakota; and Cheyenne, Lander and Sheridan in Wyoming. The records cover periods of 37 to 61 years.

The elevation above sea level, which exerts considerable effect on the relative proportion of snowfall, ranged as follows for the points in the different States: 2,371 to 2,483 feet in Montana; 1, 451 to 1, 869 in North Dakota; 1, 282 to 3, 231 in South Dakota; and 3, 790 to 6, 057 in Wyoming.

[1] Associate agronomist, Northern Great Plains Region, Soil Conservation Service, Bottineau, N. Dak.

The average annual precipitation in inches by States for the points mentioned in each State was as follows: Montana 13.56; North Dakota 16.99; South Dakota 18.39; Wyoming 14.52. The average snowfall in inches was: Montana 34.1, North Dakota 33.0, South Dakota 30.7, and Wyoming 60.4, with water contents of 3.40, 2.98, 3.00, and 5.73 inches respectively. The average percentage of snow water in terms of the average annual precipitation was 17.8 for North Dakota, 16.5 for South Dakota, 25.0 for Montana, and from 35.0 to 50.0 in Wyoming.

The average annual wind velocity in miles per hour (from 24-hour daily records) for the Montana stations was 7.9; for North Dakota it was 10.5; and for South Dakota 9.6. At Lander and Sheridan, Wyo., which are situated in or near the Rocky Mountains, it was 6.0; and at Cheyenne, which is out on the plains, 11.0 miles per hour. The maximum wind velocities during the 6 months, November to April, at the various stations ranged from 46 to 63 miles per hour.

With moderately high annual wind velocities at the various stations, and with usually stronger-than-average winds during winter and occasional storms of gale proportions, it is readily understandable that snow is almost certain to pile up in drifts during storms. Only rarely does snow fall and lie in place without drifting. Considering the climatic conditions that prevail in the area and the amount of moisture from snow that ordinarily might be conserved, it is clear that considerable additional moisture can be made available for the growth of plants.

In the Plains area, grain crops are harvested by means of binders, headers, or combines. Because of the limited rainfall, crops often are short, and it is necessary that they be harvested with less stubble than is desirable. Yet even in more normal seasons, when reasonably tall straw is produced, stubble not more than 3 or 4 inches high is frequently seen—probably the result of long-established harvesting practice. Considerable acreages of row crops also are grown and where such crops are used for fodder the ordinary practice is to harvest the stalks and leave only 4 to 6 inches of stubble.

In winter after a snowstorm these closely harvested fields usually are noticeably free of snow. On the other hand, where a 10- to 12-inch stubble is left, the

field may be completely filled with snow after a moderately heavy storm. Along the closely harvested fields, highways are likely to be badly drifted; along fields having high stubble, roads are much more likely to be open. Cornstalks left standing on the ground usually prevent most of the drifting, so that snow ordinarily is seen at a comparatively uniform depth over the entire field. Tall grass has the same effect as high stubble. Grazing lands in good condition retain much more moisture than those that are overgrazed.

It is not always possible to leave grain stubble as high as indicated by the figures in the paragraph above, because in some seasons the entire crop may not be higher than 12 to 15 inches. Nevertheless, it is to the farmer's advantage not to harvest the field too closely; if necessary, the cutterbar may be set high enough to leave a few lower heads of grain in the field so that an effective moisture-conserving stubble is retained. The additional moisture saved in one season may make considerable difference in the height of straw the next season when all the heads may be harvested. The aim in harvesting at all times should be to leave as high a stubble as possible within reasonable limits.

In corn or sorghum row crops, stubble of 12 to 15 inches will do a great deal toward holding drifting snow. A practice now being followed by some farmer cooperators in Soil Conservation Service erosion-control areas is that of leaving on the field 4 to 6 rows of corn or sorghum out of every 16 or 20 rows. The object is to provide windbreaks that lessen soil erosion by reducing surface wind velocities, and also to trap snow. In much of the northern Great Plains area, the efficiency of the standing rows, where contour farming is not practiced, will be greatest if the crop rows run as nearly as possible at right angles to the prevailing direction of the wind.

To determine the relative amount of moisture penetration from snowfall on bare and covered fields, in the early spring of 1937 a number of soil borings were made on the Wolsey demonstration area near Huron, S. Dak., on fallowed land (plowed) and on adjacent land covered with about a 6-inch growth of Russian thistle. The fallow was entirely bare of vegetation. Rather limited summer precipitation had fallen after the land was fallowed in June 1936, and from 15 to 18 inches of surface-soil moisture was present in the fallow when the winter season began. The thistle field, on the other hand, had only about 8 to 10 inches of moisture in the surface soil as a consequence of soil-moisture depletion by the thistles.

The snowfall recorded at Huron during the winter was approximately 40 inches. The spring thaw occurred in late March and early April. The average moisture penetration in the thistle field was 33 inches, and on the fallow ground 22 inches. On the fallow, most of the winter's snow had blown off, while in the thistles a great deal of it was retained. On the fallow, the increase in depth of soil moisture from the winter precipitation was only 6 to 8 inches; whereas, on the land having the thistle cover, the increase was from 23 to 25 inches. Low moisture penetrations also were observed in a number of other fallowed or fall-plowed fields in the Huron area in the spring of 1937.

A more definite idea as to the quantity of snow and snow moisture that can be trapped by crop residue of different heights—in this case grain stubble—may be had through a study of the data from snow and snow-water measurements taken in undisturbed grain stubble fields and, for comparison, in fall-disked stubble fields with observations on adjacent summer-fallowed fields on the Soil Conservation Service demonstration project at Bottineau, N. Dak., on February 27 and 28, 1939.

The total amount of precipitation (water) recorded for the three current winter months (December, January, and February) at the North Dakota School of Forestry at Bottineau was 0.99 inch. For three Soil Conservation Service farmer observers it was as follows: Rudolph Feller at Kramer, 0.63 inch; Clara Richwalski at Gardena, 0.49 inch; Arthur Vollmer, Willow City, 0.67 inch. On the demonstration area this amounted to about 12 inches of snow at Kramer, and 15 inches at Willow City. A great deal of drifting occurred during February.

The average depths of snow and snow water for two general locations about 15 miles apart, east and west, were as follows: At Kramer a field strip having a 6-inch undisturbed stubble had an average of 4.6 inches of snow with 1.10 inches of water; two fields having 12-inch stubble, had 9.9 inches of snow with 1.69 inches of water. It should be recalled here that the snow measured represents the winter's accumulation, which was settled and packed and had a relatively high water content.

Near Willow City two fields with 10-inch undisturbed stubbles had an average of 7.5 inches of snow with 1.94 inches of water; one field with a 12-inch stubble had 10 inches of snow with 2.36 inches of water; and a 14-inch stubble field had 11.4 inches of snow, with 2.46 inches of water.

Near Kramer, a fallowed field strip (east-west) free of vegetation and worked with a duckfoot for the last operation, adjacent to an undisturbed stubble field

where measurements were made, was almost completely bare. A similarly fallowed north-south field strip, adjacent to a sampled stubble field, also was mostly bare except for a drift along the stubble on the west.

Since on the average the highest yields of spring grains are produced from the early seedings, it has been a fairly common practice with farmers in this section to fall plow for small grain in order to be able to sow a larger acreage the following season. Farmers are beginning to observe that fall plowing has not given as good results as spring-plowed stubble. It seems fairly evident that the conservation of snow moisture in stubble, together with the protection it affords the soil from erosion and evaporation losses, plays a significant part in producing the differences noted. Without going into the relative values of fall plowing and fallow in crop production, the comparison between the amount of snow retention in high grain-stubble and on fallow emphasizes the value of crop residue in snow-moisture conservation.

The value of a special disk for fall tillage, to leave most of the crop residue on or near the surface of the soil, is being studied in its relation to soil and moisture conservation. The disk is set to cut the soil deeply, so as to provide a large moisture-absorbing capacity. After disking, much of the stubble remains partially erect and serves to catch snow, reduce evaporation, and to prevent soil blowing. Naturally, the amount of residue present will materially affect results. In the use of this implement for fall tillage, moderately high stubble is very important.

The snow coverage on several fall-disked stubble fields was measured. Here the special single disk, heavily weighted, had been used, and on all these fields the disk was set at a sharp angle so as to cut deeply and thoroughly. In this operation the field is left with moderately high ridges having depressions or valleys between.

A field strip near Kramer, with a rather thin 6-inch stubble that had been fall-disked with the special disk, trapped very little snow. This field was about half bare, with the remainder covered thinly with snow and a low drift near the buffer strip on the west.

The fall-disked fields on cooperators' farms near Willow City were well blanketed with snow—the result of their covering of fairly dense stubble of 10 to 14 inches. Much of the stubble remained partially erect on the disked fields. Snow measurements were made on both ridges and midway between ridges, in all fields. The depth of snow in depressions averaged 7.8, 10.0, and 8.5 inches respectively in stubbles of 10, 12, and 14 inches, with water contents of 2.41, 2.40, and 2.28. The average depths of snow on the disk ridges in the three fields were 1.8, 3.6, and 0.0 inches.

From the above results it is seen that considerable quantities of snow moisture may be conserved by leaving moderately high stubble on harvested fields. Where the snow is lodged, the percentage of accumulated snow water that finds its way into the soil naturally varies with the nature of the thaws and the receptivity of the soil. On the moderately level fields in this section of the Plains the moisture absorbed usually is considerable.

Another important purpose served by stubble on the ground in winter is that it protects soil moisture from evaporation. On the average, the humidity of the air during zero and subzero temperatures is low. Strong winds during such periods remove considerable amounts of soil moisture. This may be verified readily by examining and comparing plowed fields and adjoining stubble fields, preferably on loam or sandy loam soils, after several windy days in winter following a light snowfall. Surface-soil moisture is almost certain to be found anywhere in the stubble, while on plowed or fallowed land a loose dry mulch an inch or two deep frequently is found at the soil surface.

Frequently large straw piles are seen in winter in harvested wheat fields of the Plains country. It is true that they are to a large extent a source of much needed roughage for cattle, but in many instances they merely are burned the following spring to clear the land for succeeding crops. A considerable proportion of this straw could be left as stubble in the fields to aid in conserving snow moisture as well as soil.

Thysell,[2] in a recent bulletin on the conservation and use of soil moisture at Mandan, N. Dak., and covering results of 20 years of continuous investigation, reports that among other factors the quantity of water available for crop use in the soil at seeding time "is directly related to the presence or absence of stubble cover on the surface."

In a study of the annual and average quantities of precipitation during the major parts of the fallow period, and the percentages of it saved in the surface 6 feet of soil under alternate cropping of wheat during the period of 1914 to 1934, it was found that an average of 4.48 inches was saved during the entire fallow period. For the 19 fallow periods, 2.31 inches were saved during the first major period, that is, harvest to seeding time. This represented the fall and winter following harvest, when the fields were covered with

[2] Conservation and Use of Soil Moisture at Mandan, North Dakota. By J. C. Thysell. U. S. Department of Agriculture Technical Bulletin 617. 1938.

stubble which conserved snow moisture and reduced loss of moisture from evaporation. During the second fall and winter period, when the fields were bare as a result of the fallow operations, 0.76 inch of moisture was saved. During this period the presence of water already stored in the soil, as well as the lack of stubble protection, contributed to the comparatively low amount of water saved during the time of the last major period before seeding. The average saving during the second period, or during the time of tillage operations for fallow, was 1.42 inches.

These experiments, in which actual moisture determinations were made several times during the growing season, emphasize the value of a stubble cover in conserving moisture.

Thysell also found that in the production of wheat and corn "Approximately one-half as much water is used during the dormant period, as is used during the growing period. The lowest average use comes under treatments having stubble cover, and the highest use comes under treatments where the ground surface remains bare, such as fall plowing, corn ground and summer fallow. When ground during the dormant period is covered with wheat stubble, from 64 to 68 percent of the precipitation is used. Under corn stubble and on fall plowed corn ground, 76 percent of the precipitation is used. On fall-plowed wheat land, 80 percent is used, and under fallow, 90 percent is used."

Duley and Kelly [3] in experiments at Lincoln, Nebr., have demonstrated the value of straw residue in promoting the penetration and absorption of moisture by soil. This information has a direct bearing in the problem of increasing the moisture content of soils low in organic matter.

The preservation of a reasonably high crop-stubble protects the soil from wind as well as water erosion. While on the average only a very limited amount of erosion occurs in the winter when the ground is frozen, the stubble protects the land during late fall and early spring when the winds very often are high.

Another important use of this vegetative cover is that it serves as a source of humus for the soil. It should be remembered, however, that the plowing under of excessively large quantities of straw may depress yields.

A reasonably large crop-residue cover in winter likewise results in added protection for wildlife. Birds are of considerable economic importance to agriculture, in that they tend to hold in check insect pests that infest crops.

With proper utilization of crop residue on much of the cultivated land of the northern plains, it should be possible to conserve from 2 to 3 inches of the snow water which now in most instances is very largely lost. The farmer may feel that he can afford to leave only as little feed as possible in the field; yet, if some attention is given to holding the winter snow on the land, it will enable him to grow a larger feed or other crop the following year.

[3] F. L. Duley and L. L. Kelly, "Effect of Soil Type, Slope, and Surface Conditions on Intake of Water." Research Bulletin 112, Agricultural Experiment Station, University of Nebraska, Lincoln, Nebr. May 1939.

LAND USE IN NORTH DAKOTA

(Continued from p. 222)

The adjustment program, involving purchase, development and management of the land, has met with general approval from all groups in the county. Businessmen believe it is better for them to have a smaller number of self-supporting, prosperous families in their trade territory than a larger number of operators with low purchasing power. The sportsmen of the State are in favor of the program, as wild game is being protected under a system of game management supervised by the Soil Conservation Service; this management ensures continuous good hunting of native upland game birds as well as the imported ring-necked pheasant and Hungarian partridge. The larger stock water reservoirs have been stocked with game fish, and a limited amount of food-bearing water plants for water fowl have been planted. Deer and antelope are found in limited numbers and these will increase under a system of proper game management.

Public officials favor the program because public expenditures have been reduced. While some taxpaying property has been taken from county records, county officials believe that the county's share of revenue received by the Government for the use of project lands will equal the amount of taxes actually collected from such lands during the period preceding the purchase program. The closing of 16 rural schools as a result of population adjustment has resulted in a saving of $12,800 annually to the taxpayers. This has been done without impairing school facilities for children remaining within the area, and in many instances, it will be a factor toward improving educational advantages. Reduction in various forms of relief and subsidies formerly paid to families who have moved from the area has been the largest single factor in reduced public expenditures.

REHABILITATION OF OREGON RANGE

By FRANK B. HARPER [1]

NOTICEABLY concrete progress in the Jefferson County, Oreg., land-utilization project is attracting the attention of central Oregon ranchers and agriculturalists. The project, now in its fifth year of operation, includes 180,000 acres of land which prior to and during the World War period were subjected to unprofitable settlement for dry-land grain farming. The land is now being returned to its best use as livestock range.

Grazing, held down to the safe carrying capacity of the range, and the reseeding of thousands of acres of abandoned farmland to grass are cited by A. M. Christenson, project manager, as major steps taken to conserve this important block of Oregon's acreage. The available grazing is distributed in cooperation with stockmen who are eligible for grazing permits in such a way as to maintain on a sound economic basis as many operating units as the resources in the area will permit.

Many miles of sturdy fence dividing the range lands into usable pastures, dozens of springs and other sources of stock water, and miles of trails enabling livestock to reach the water of the Deschutes and Crooked Rivers are among other developments that may be mentioned as bringing about the land-use transformation that is gaining the attention of ranch operators in central Oregon.

In 1934, officials of State college and the experiment station, the State land-planning board, and members of the State relief administration, proposed Government purchase and development of submarginal lands in central Jefferson County. Many of the farms were abandoned and were blowing down to the subsoil to which depth they had been plowed in the attempt to sustain crop production without irrigation in an area which has an average yearly moisture of 8 inches or less. Other thousands of acres were in nearly as hazardous a condition as a result of unlimited grazing that had kept the bunchgrass eaten off to its roots until it gave way to cheat, or to nothing at all. The central Oregon area was chosen, secondly, because the conditions represented those found over a larger territory extending north and east through all or parts of Wasco, Sherman, Gilliam, Morrow, and Umatilla Counties in Oregon, and over the line into Washington.

Since the Central Oregon project opened in January 1935, approximately 100,000 acres have been bought. Another 2,000 acres have been recently optioned for purchase. The project does not interfere with development of the proposed north unit of the Deschutes irrigation project, but does promise to complement it effectively in the eventual over-all agricultural development of the area, through making grazing land available to farmers who will operate the lands to be irrigated. No purchases have been made in the 50,000 acres of wheat land lying on either side of United States Highway No. 97 through Madras, Metolius, and Culver, which will eventually come under irrigation when the Deschutes irrigation project is completed.

The big problem in this territory, as Mr. Christenson explained it, is the making of adjustments that will permit livestock operators to provide themselves with properly balanced units through assured spring and fall range and carry-over feed. The land-use development has been based on the proved theory that these needs can be met with practices that will at the same time stop the destruction of soil resources. Accordingly, some 14,000 acres of land, formerly cropped, have been seeded to hardy crested wheatgrass. Another 2,000 acres were selected to be seeded this fall, and 20,000 acres more in the future.

Four hundred miles of rusting fence that enclosed farm units ranging from 40 to 1,200 acres and averaging 250 acres have been removed, and another 45 miles of such fencing will be taken out this next year. New pasture boundary and drift fences totaling nearly 150 miles have been built, and 30 miles more will be added this year. Separation corrals, a sheep trail, and cattle guards further help permit holders to obtain maximum use of the range without abusing it.

Operators who depended upon this grazing in the past are given special consideration in distributing the available grazing privileges. The range is being stocked on safe carrying capacity, and the grazing permits are based on farm and ranch surveys made earlier to determine operators' needs. Among the stockmen benefiting from this plan are some of the families who moved from the project area to adjacent communities, as well as the 8 ranchers remaining inside project boundaries after 49 had relocated.

(Continued on p. 231)

[1] Associate information specialist, Pacific Northwest Region, Soil Conservation Service, Spokane, Wash.

Erosion-Control Lessons From Old-World Experience

V. THE LOST AGRICULTURE OF TRANS-JORDAN

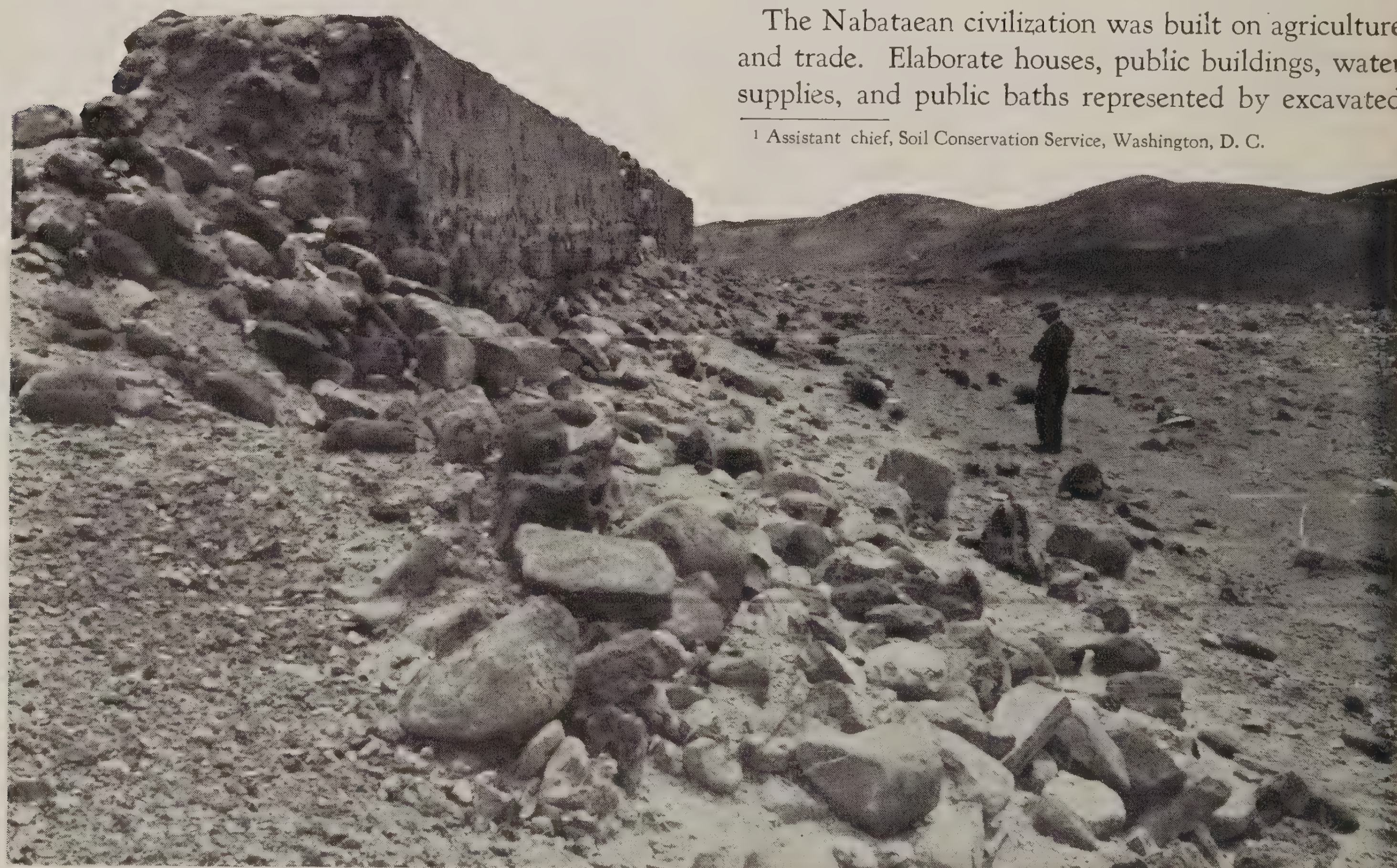
By W. C. LOWDERMILK [1]

FOR a soil conservationist, the study of Trans-Jordan as it is today, compared to what evidence reveals it must have been during its Golden Age of agriculture, is most revealing and serves as a warning that cannot be ignored. Generation replaces generation in population, but fertile soils once gone cannot be replaced, or the remaining productivity saved for the future, without a change in the attitude of mankind toward his occupation of the earth. A new national ethics and economics must be developed which will recognize that a nation has a moral obligation to the earth and its future inhabitants, and which will coordinate the national interest and individual initiative in the use of land. Second to our descendants, our most direct link with the future is through the land, in the abundance or the poverty which we pass on to those who follow.

During the past 6 years exploration and spade work of archaeologists have turned back the pages of history in Trans-Jordan 3,000 to 4,000 years, and brought to light the amazing agricultural development and civilization of the Nabataeans. Today, more is known about the Golden Age of agriculture and the former populations in Trans-Jordan than has been known since the Nabataean civilization was blotted out some 1,200 years ago by the Arab invasions. Petra, the Nabataean capital, was destroyed—it slumbered and crumbled in the fastness of its desert gorge, unknown to the world until its spectacular rock carved tombs were rediscovered in 1812, by the Swiss explorer, John Lewis Burchardt. Recently, Dr. Nelson Glueck, director of the American School of Oriental Research, has been directing excavations of the Port of Solomon, used later by the Nabataeans near Aqaba on the Red Sea.

The Nabataean civilization was built on agriculture and trade. Elaborate houses, public buildings, water supplies, and public baths represented by excavated

[1] Assistant chief, Soil Conservation Service, Washington, D. C.



An ancient dam which once impounded waters for the Roman city of Ma'an. When the reservoir silted up the stream cut out a new channel to one side.

ruins show high skill and technique in construction and adornment. Now all that remains of this glorious past of beautifully built cities and carefully cultivated fields protected by rock-wall terraces, are crumbling ruins. Abandoned fields, ruins of terraces, and remnants of former forests reveal a change from ancient prosperity to modern poverty and decadence.

The sweep of human struggle from the first groping of the food gatherer to modern times is filled with rises and falls of cultures and empires. Throughout a long period of 6 to 7 thousand years from the late Stone Age, occur two epochs of "silent centuries" of which few remains of permanent construction of houses, cities, or works are found. They occur from about 2000 to 1300 B. C. and from A. D. 1500 to the present; these are two epochs of tent dwellers. Hords of fierce nomads had at the beginning of these two epochs destroyed the works, cities, and agriculture of advanced civilizations, but they did not rebuild. They continued their tending of flocks and pitched their tents where water and grass might be found. Most of the advances in the use of land and conservation of water fell into disuse. About 1300 B. C., late Bronze Age people began a period of building cities, usually located near big springs, and restored a sedentary agriculture. Evidence is found about a Bronze Age site near Jerash which indicates that terracing was used by the inhabitants at that time.

The children of Edom still tend their flocks among broken-down terraces and watch the yearly rains carry away the remaining soils from their cultivated patches. They still scatter scanty seed grain on unplowed land after the first rains and plow it in with a primitive plow, and pray to Allah for the harvest. The yields are from threefold to fivefold in average years, sometimes as much as fifteenfold in the best remaining ground. Some years scarcely are the seed recovered in the harvest. They eke out a meagre existence and care little for permanent abodes. Their hundreds of goat's-hair tents appear as huge bats' wings outstretched in the ravines or on the hills. Herds of goats appear as flocks of blackbirds searching among the rocks for scanty vegetation and roots.

The Nabataean empire extended from the Red Sea to Damascus, and an unknown extent into Arabia, but it was never able to overcome the Greek league of 10 cities known as Decapolis, covering the western-central area of Trans-Jordan and part of Palestine. The origin of the Nabataeans is obscure, but they are believed to have been a Semitic tribe of nomadic Bedouins of Arabia, who swept over in a wave from the hungry and thirsty desert. After their conquests of the kingdoms of Moab and Edom they settled down to a fixed abode and developed a remarkable agricultural civilization.

As has occurred many times in these lands, the wild desert men, always hard pressed for food, invaded the cultivated areas. They replaced the former settlers and followed agriculture until they in turn were supplanted by another wave of hungry desert people.

Prior to Dr. Glueck's survey and study of about 500 Nabataean sites, it was the general opinion that the inhabitants of Petra and other large Nabataean centers owed their wealth chiefly to the commerce of caravan routes. Petra, as capital of the Nabataean kingdom, was known as an important caravan center, connecting Egypt and Arabia on the south, Syria on the north, Gaza, the port on the Mediterranean on the west, and Babylon to the east. But these field studies, in the past 6 years, have disclosed the remains of a former intensive and extensive cultivation of the land surrounding Petra and other centers. Broken-down terrace walls in the catchment area of Wadi Musa, draining into the gorge of Petra, bespeak of a former intensive cultivation of this entire area. The valley of the Wadi Hesah, also shows evidence of having been terraced over the entire extent of its gentle to steep slopes. It may be assumed that the more productive lands of the plateau were in full use before such elaborate effort would be made to cultivate slopes of gradients up to 80 percent.

These works of intensive land use have fallen into decay and disuse. Erosion has followed close behind the nomad destroyer of the inhabitants and houses of settled communities, and has completed the destruction by washing away the soils, and filling the drainage channels with erosional debris.

Striking evidence of this is found in the Sik or gorge leading from the catchment area into the site of Petra. A remnant of a former fill of erosional debris was left in the gorge 3 feet above a water conduit cut into the red sandstone wall, now 7 feet above the floor of the gorge. This remnant indicates that at some former time, after the abandonment of Petra, storm run-off draining the catchment area had brought down and deposited erosional debris to a depth of 10 feet above the present canyon floor level, and that still later, the storm run-off had eroded out this material to the present level.

Many such successions of the filling and cutting of drainage channels have been observed by the writer in China and in the United States. They are only ob-

vious symptoms of a cycle of destructive soil erosion. At first, when erosion of sloping lands is highly accelerated, the streams of storm run-off are overcharged with soil and debris, as they come off the steeper slopes and, on reaching the lesser slope of the main drainage channel, they are unable to carry the load of much material; they become overloaded and drop a part of the material and fill the channels. As time goes on the readily erodible soils of the slopes are washed away or natural vegetation gains more control. Streams of storm run-off then flow down the slopes carrying less material than their capacities and pick up deposits of erosional debris. These deposits are cut out and moved farther downstream to be deposited again in wider and gentler reaches of the channel.

From this evidence in the Sik and in the catchment area of formerly highly terraced fields, soil erosion reached a high rate in the Wadi Musa catchment on the abandonment of agriculture and the break-down of terrace walls. But as the terraces were washed out and natural vegetation gained more control, storm waters ceased to be loaded to capacity and began to cut and carry farther downstream the deposits in the Sik or gorge, as shown by remnants of former fills. The highly developed agriculture of the Nabataean period was neglected after the nomad conquest, and soil erosion brought about destruction of the land. This, more than the cessation of caravan trade, in my opinion, explains the extinction of Petra and its unique civilization.

The Nabataeans not only intensified agriculture in the more favorable areas, but pushed cultivation and intensive use of the range farther out toward the desert than ever was done before or since. They were able to do this because of their ingenuity in the conservation and utilization of rain waters. Thousands of cisterns were a part of their program for making habitable the year-round areas which otherwise would have been impossible in dry seasons. Some of these cisterns are very large and are dug out of the solid rock, with only a small opening for the water to be drawn out. Many of the fortresses on hilltops bordering the desert had cisterns sufficient to supply water for a hundred or more people the year-round. Some cisterns were made of rock and plaster and had conduits which made water available for irrigation. Some were definitely designed and placed for the use of flocks so that they might feed high up on the hills without going great distances to water. Near some cisterns were found stone troughs for watering herds. In some sites every dwelling appears to have had its own cistern and to have had no other source of supply, while others appear to have been needed to supplement the water from a spring because of large numbers of the population. The people were most ingenious in utilizing a depression to form a reservoir, by building additional walls to enclose it. Rain waters were collected from slopes and rock surfaces by ingeniously located banks and diverted into cisterns.

It is significant that the same rainfall of today is sufficient to fill these cisterns to capacity. A cistern was found on one occasion to be filled largely with water as late in the summer as August. In one of the largest cisterns in Petra, blind fish were found, giving evidence of long existence. About the High Place, or Citadel of Petra, which served as a refuge for the inhabitants during attacks, the great rock surface of the mountain top was converted into one huge catchment area for collection and storage of rain water in cave cisterns provided for a long siege in an otherwise waterless area. The Nabataean villagers sometimes built cisterns out on the desert, in places known only to themselves, to which they might flee in times of danger or attack.

In the great Wadi el Hesah, there is today a green cultivated area on a slope, which presents a striking contrast to the barren rocky surroundings. The entire slope once was terraced and cultivated. There are remains of ancient rock conduits to carry the spring water out to some former cultivated terraces. But today the spring waters flow by gravity at will, and a large area is swampy and seeping with water among the weeds and rushes. The water is only partially used today. A good stream is flowing in the Wadi, but the former irrigated terraces are broken and unused; sand and debris from flood waters have piled upon what otherwise might have been garden lands. Numerous olive and wine presses of stone have been found on slopes of this Wadi, which formerly were cultivated. Many of the ancient terraced gardens are now thorny wastes. With terrace walls neglected for centuries, much of the good earth has washed away exposing the ugly naked rock and adding ruin to the country.

Many ancient sites show remains of terraces, but only a few are still in use. Most of them are broken down and the soils have partially or entirely washed away through the gashes and breaks. Modern farmers are, for the most part, content to rely upon the work of farmers who preceded them by 2 thousand years or more, and do little to repair or rebuild terrace walls—just as practically nothing is done to make available the hundreds, or even thousands of ancient cisterns which, with cleaning and repairs, could be

put to service for conserving storm waters for dry seasons.

On the basis of his surveys, Dr. Glueck estimates that during the early Iron Age, about 600 B. C., Trans-Jordan had a population of 450,000 as against 300,000 today, but that the greatest density of population occurred during the Nabataean period in the time of their independence and later under Roman and Byzantine domination. This period lasted about 1,000 years, approximately from 300 B. C. to A. D. 700. The population during that period is estimated to have been more than three times that of today, or about one million inhabitants.

Extensive forests once covered the highest parts of the Trans-Jordan Plateau, whereas today only an occasional Butum or Terebinths tree escapes the charcoal pit, and grows up among the ruins on an ancient site. If it covers a grave it becomes a sacred tree and is allowed to remain, though it is browsed by goats as high as they can climb or reach. Near Jerash, at Ajlun, a considerable forest area still remains where trees are rapidly being cut and the rocky soil is being plowed and sown to grain. Soil erosion may be noted on such sloping fields, and abandoned fields where the land has been impoverished by erosion. The process of shifting cultivation still moves on. The ancients reserved this land for forests, and the area appears never to have been cultivated before.

Near Petra, at Al Hish, in the region of Mount Seirat, are the remains of what appears to have been an extensive forest at an altitude of about 5,000 feet. Doubtless, here grew the timber which was transported to Ezion Geber on the Red Sea and used to build Solomon's Red Sea fleet. During the World War, when the Turkish railroad was cut off from its usual coal supply and was in need of fuel, a branch line was run to this forest area, and the remaining trees were slaughtered for fuel without regard to restocking. Happily, a few specimens remain to show what the forest stand was like, but the trunkless bases of the old giants are like great slabs of black stones scattered about over the land.

Today, all the country surrounding Petra is barren and desolate. A few irrigated trees and orchards on the terraces of Elji are all that remain of what were once famous and extensive orchards, vineyards, and gardens. Four other nearby ancient sites with remnants of terraces also appear to have been agricultural areas supplying the markets of Petra.

REHABILITATION OF OREGON RANGE

(Continued from p. 227)

The fee charged for grazing is approximately the same as that charged in the adjacent forest grazing areas. Twenty-five percent of the collections are paid by the Federal Government to the county to be used for school and road purposes.

Stock-water development, to facilitate more even use of the range, thus far has included 50 springs and windmills installed with troughs, more than half a dozen catch-basins or small earth dams for storing run-off water, and 15 miles of trails.

"In spite of the fact that this has been one of the driest seasons in years," the project manager said, "livestock in the project show satisfactory gains, both from available grass and improved water conditions. There has been some really remarkable recovery on areas protected during the last 4 years, partly because of grazing protection and partly as a result of two favorable growing seasons."

On the whole, grass seedings have been quite successful. The first were made in the spring of 1936, and all seedings that year and in 1937 gave good stands, with better than average rain. The 1938 fall seedings have had to fight dry weather, but enough grass plants remain to produce a successful stand with a good season. As the area becomes increasingly revegetated, the carrying capacity will increase, resulting in an increase in revenue to the Government and to the county.

Labor for the fence construction, dismantling abandoned farm buildings and other operations is provided by a W. P. A. camp of 100 men near the ghost town of Lamonta, employing Jefferson, Crook, and Deschutes County workers. Popular among the developments thus made possible is the Crooked River recreation area about 14 miles southwest of Madras. The 10 acres of naturally landscaped picnic grounds with table, cooking, water, and other facilities attracted 1,400 cars from mid-April to the Fourth of July.

Reduction in school and road-upkeep costs for the county, provision of better food and shelter for beneficial wildlife in the protected revegetated areas, rodent control, and fire protection are among other benefits reported by Mr. Christenson as resulting from the land-use program.

NOTES ON RECENT DEVELOPMENTS IN THE INFILTRATION PROBLEM

By G. W. MUSGRAVE [1]

IF ALL rainfall could be retained near its point of contact on the land surface there would be no run-off and no erosion; all the rainfall would be conserved, made at least potentially available for plant use. Of course we know, however, that retention of all the water that reaches the earth's surface as rain, snow, or other forms of precipitation is impracticable and might indeed in some instances be undesirable. Yet, generally speaking, a much larger proportion of this precipitation water could be retained with great benefit to the plant and animal life of the globe.

Thus it is extremely important that the rate of infiltration be maintained to an extent sufficient to permit a goodly portion of the rainfall to be retained by the soil. The consumer of water whether an urban or rural dweller, and the consumer of the produce of the land whether such produce is of vegetable or animal origin, have each a vital stake in the matter. The biologist, agronomist, soil technologist, and engineer are concerned likewise, since to a considerable degree they are dependent upon available water for the success of their plans, be those plans for research or for operations on a practical scale. As time goes on and more information is accumulated, additional ways are continually disclosed by which such practices are of further benefit to man.

In the humid regions of the eastern seaboard, the conservation of water is not commonly considered an important problem. Droughts do occur, however, at rare intervals, as during the summer just past, and reservoirs supplying cities with water are depleted and crops are injured. Furthermore, and ignoring these rare droughts, it is very common to find that in certain seasons the crops cease to thrive and show evidence of lack of water. During July and August, pastures become brown and production is limited despite the fact that the annual rainfall is 40 to 50 inches. Technologists thus far have given little thought to the possibility that these seasonal pasture failures may be basically a moisture conservation problem, and that they are the consequence of an excessive drain on water supplies resulting from high evaporation and transpiration at this time of the year. It is interesting to speculate upon what would be the effect were it possible to put into the soil 25 percent more water than today enters our agricultural lands. There is good evidence that in earlier days something of this kind actually did occur: farmers still call the long, slow rain (a large part of which enters the soil) a "million dollar rain."

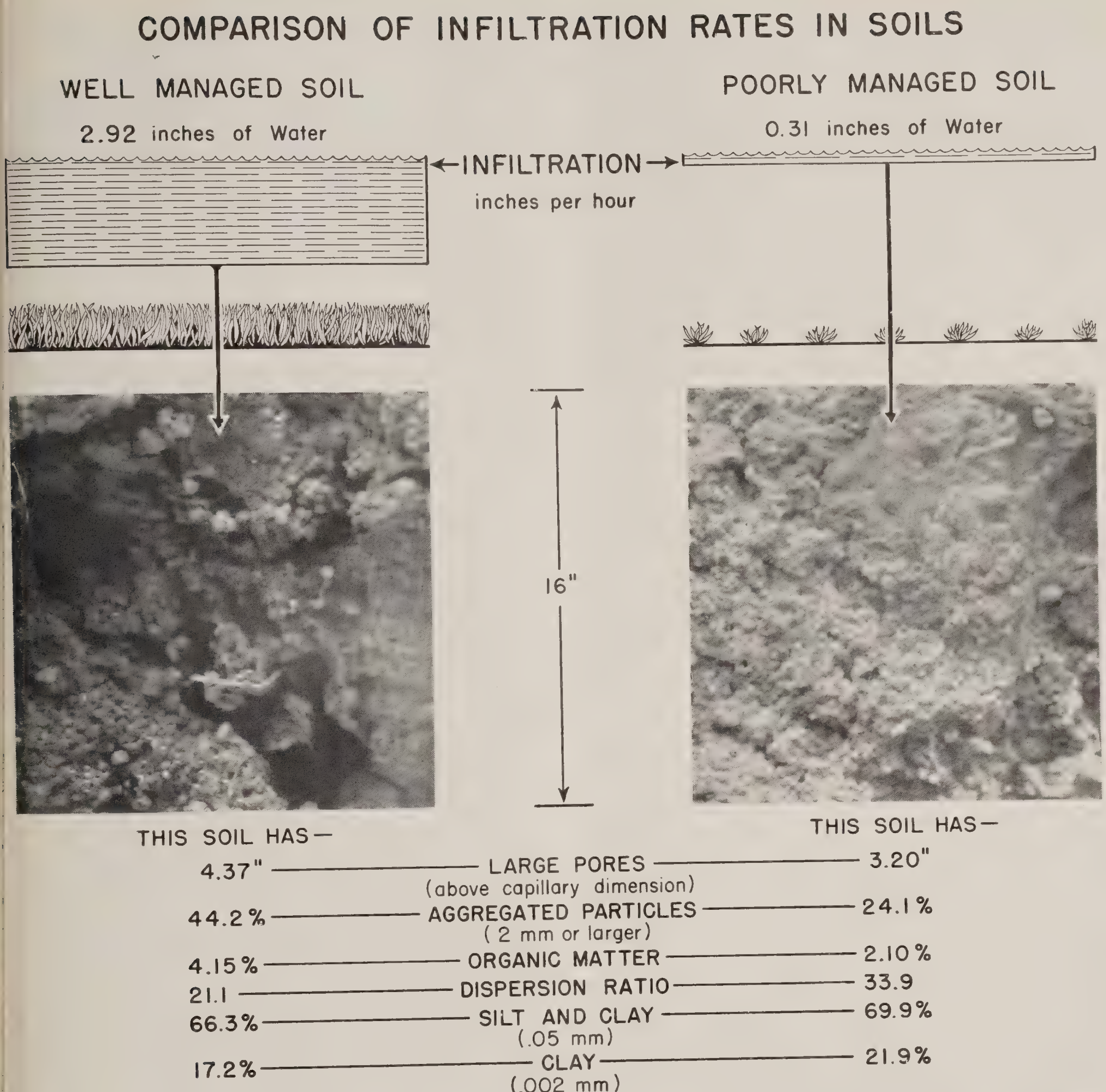
Of course the problem in the lower rainfall areas is more important, since here shortage of water may be said to represent a chronic condition. Ordinarily in such areas a comparatively small increase in available water results in greatly improved conditions, or it may represent the difference between success or failure of agriculture over a wide region. We usually recognize this situation, while we often overlook the exceedingly common summer shortages in the humid areas.

All practical workers know that soils differ widely in their ability to take in water. Farmers know that certain fields may have water standing on them for several days following a rain while other fields take up the rainfall rapidly. A striking example of the differences in infiltration for different soils may be viewed from an airplane on almost any trip soon after a storm. The land surface has a patchy appearance; some of it is covered by water and some is not; some small streams show the recent high-water mark, others do not. The result is a pattern not unlike that of a soils map.

Our Service showed as early as 1933 that the infiltration of Marshall silt loam is much higher than that of Shelby silt loam, though both are soils of the Corn Belt and in the same general climatic region. At the same time it was found, by a comparison of measured amounts of water and soil loss, that the run-off was much greater from the Shelby and likewise that the degree of erosion was much larger. The Davidson and Iredell soils of the Southeastern States are known to differ widely in their rate of water intake. Measurements on Davidson clay loam near Monticello, Ga., and Iredell near Lexington, in the same State, showed, for the two sites studied, infiltration rates of 2.47 inches per hour, and 0.04 inch per hour, respectively.

The interesting and important point which has been established recently is that the method of soil management has a very great effect on infiltration. This is due to the fact that the entrance of water into a soil

[1] Head, infiltration studies, Soil Conservation Service, Washington, D. C.



profile is governed largely by the size of the pores; soils having a large amount of pores larger than those of capillary dimension usually have high infiltration rates. Such large pores commonly are associated with a soil structure having the individual particles largely aggregated with soil aggregates behaving like large particles, and with relatively large pores between them. Recent studies also have shown that the state of aggregation is conditioned upon, among other things, a fair quantity of organic matter. In other words, soils high in organic matter, high in aggregation, and consequently having a considerable amount of large pores, have high infiltration rates. Clearly, these are the soils which have been the beneficiaries of good soil management. Conversely, soils which have been intensively cultivated and managed, with inadequate return of crop residues and other forms of organic matter, show these deficiencies in their physical and chemical properties so that the particles are largely nonaggregated and highly dispersed, the pores are of small dimension and the infiltration rate is low. The characteristics of a well managed soil in contrast to a poorly managed soil may be seen in figure 1.

The contrasting conditions portrayed in this figure represent two soils of very similar texture but widely different in structure. The high infiltration is associated with large individual pores, which in turn are associated with nearly twice the amount of aggregated

particles. The high aggregation is associated with nearly twice the amount of organic matter and a considerably lower dispersion ratio. The poor soil, however, has a larger amount of clay and colloid in the subsoil and undoubtedly swells to a greater extent upon addition of water. The measured amount of infiltration for the better soil is 4.03 inches and for the poorer soil is 0.31 inch per hour.

Thus, we are gaining some light on the factors which determine the relative infiltration of different soils. In a study of 68 important soils of the United States, it was found that the principal characteristics affecting infiltration included the amount of noncapillary porosity, the degree of aggregation, the amount of organic matter in the surface soil, and the amount of clay and colloid in the subsoil. The greater the amount of clay and colloid the lower the infiltration, while the greater the amount of organic matter and degree of aggregation, with resulting greater noncapillary porosity, the higher the infiltration.[2]

Other work has shown, of course, additional factors which determine the rate of intake of water by a soil. The degree of turbidity (muddiness) of the surface water is one of these important factors. The presence of forest litter, a straw mulch, or a vegetal cover upon the surface adds greatly to the improvement of the infiltration rate.

These effects are substantiated by actual measurements upon natural soil profiles in the field. Near Chickasha, Okla., two similar areas of Vernon fine sandy loam were compared; the soils differed only in that one had been intensively cultivated and later abandoned, while the other (covered by a dense sod) never had been plowed. Water was applied to the two sites in the form of artificial rain. On the abandoned soil, after 40 minutes of rainfall the infiltration was only 0.28 inch per hour. (See figure 2.) On the corresponding area, however, where the sod had not been plowed and there was a much higher content of organic matter and a higher degree of aggregation (although the profile in general would be described under the term "Vernon fine sandy loam" as was the first soil), the infiltration was 2.95 inches per hour (figure 3). In both instances the sites had received, 24 hours in advance, an application of artificial rain sufficient to bring the rate of run-off to a constant value; thus the infiltration figures cited above are for the soils when thoroughly wet.

Some soils, such as Houston clay, have a very high infiltration in their dry or nearly dry state; but because of their high content of colloid these soils when wet swell to such an extent as virtually to prevent infiltration. While we know of no studies showing definitely that this condition has been improved by treatment, it is reasonable to suppose that this high rate of swelling may be mitigated to some extent by practical treatments, such as the incorporation of organic matter.

In any area there may be operating something of a vicious cycle, if the situation is left uncontrolled. It goes something like this:

(1) Low infiltration followed by poor vegetal cover;

(2) poor vegetal cover followed by high amounts of surface run-off;

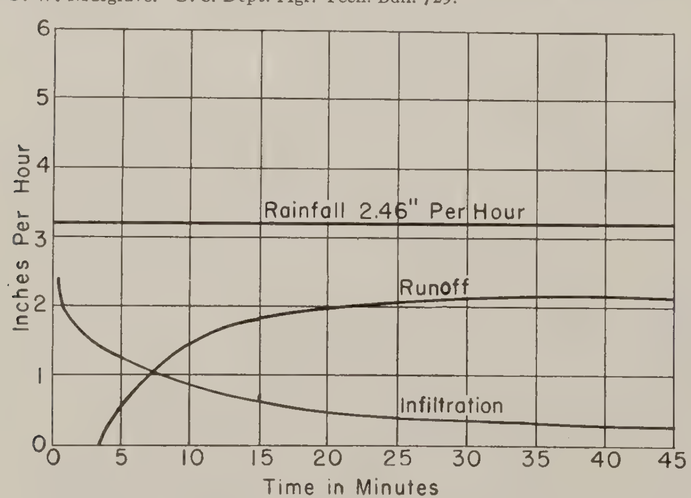
(3) high run-off followed by loss of aggregated and more porous portion of the surface;

(4) loss of porous portion followed by lower infiltration.

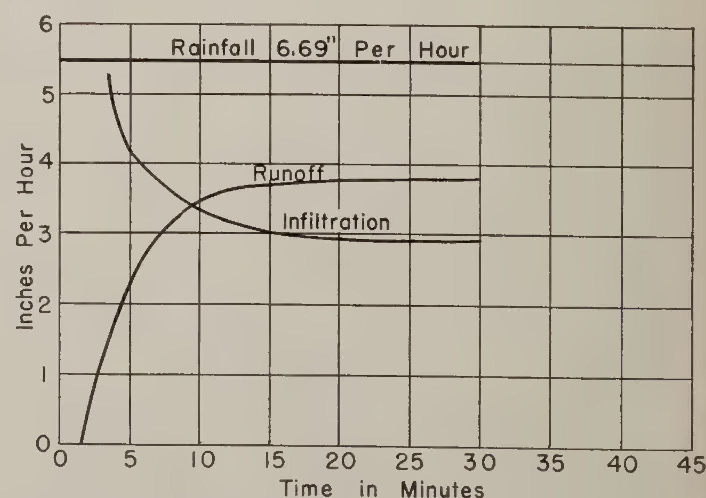
Such a cycle of events probably is quite common, and while there may be exceptions they are relatively infrequent.

Probably the most significant thing that has been learned from recent studies is the very common association between good land use and relatively high in-

[2] The details of this investigation are given in "Relative Infiltration and Related Characteristics of Certain Soils," by G. R. Free, G. M. Browning, and G. W. Musgrave. U. S. Dept. Agr. Tech. Bull. 729.



VERNON FINE SANDY LOAM—ABANDONED LAND



VERNON FINE SANDY LOAM—VIRGIN, PASTURED

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

REPORT OF THE CHIEF OF THE SOIL CONSERVATION SERVICE, 1939. Office of Superintendent of Documents, United States Government Printing Office, Washington, D. C.

One of the interesting features of the work of our Service is the yearly check-up. This 78-page report by Dr. Bennett is sufficiently complete and sufficiently alive to supply the demands of the most exacting seeker after the facts concerning the operations, objectives and attainments of the S. C. S. during the fiscal year just past.

Those of us who have been working with the Service since the early days of organization cannot but note with satisfaction the definitely solid quality of the Introduction. Here the soil conservation district set-up is reported and explained with minute attention to the details of the basic principles underlying this "new mechanism" which now "takes its place beside the demonstration area" as an important instrument for protective use of the land and water resources of the Nation. "Five years ago the Government, with the cooperation of farmers, was leading the fight against soil waste. Today farmers, with the assistance of the Government, are taking more and more of the initiative, and with a new weapon, the soil conservation district." These two sentences, from the opening paragraph of the report, are most significant, particularly when backed by the June 1939 figures—36 States had passed soil conservation districts laws, and 161 districts had been established and were operating to design, from the ground up, land-use patterns for the stability and permanency of a real agriculture and for improved social and local government functioning.

The soil conservation district set-up, as it has evolved throughout the past 5 years, is defined in detail by Dr. Bennett, from landowners' petition to the State soil conservation committee to the appointment of supervisors and the part of the Service as technical adviser upon request. It should now be plain to all that district organization has been simplified into an easily understandable and easily accessible process, and that farmer initiative is the nucleus around which programs for acceleration of progress in conservation of land and farm or ranch community rehabilitation can be built.

The advantages of soil conservation districts programs, as already noted in many areas, are discussed in considerable detail, while coordination of governmental agencies in providing assistance and advice to the new districts is pointed out as necessary to meet the complexity of problems involved and to avoid stalemate of achievement.

The reorganization of the Department of Agriculture in October 1938 is explained as a further step that has served to speed up the program of the Soil Conservation Service and, following this, figures are given to show the economic results of soil and water conservation.

The report now develops into a division by division, section by section, and unit by unit factual account of the year's work as carried on by the Service in approximately 900 projects and covering more than 200 million acres of land in 47 States and Puerto Rico. Under the main heading "Operations" the extent of work accomplished during the fiscal year is grouped as to farm planning; management of cropland, pastures, orchard and vineyard, range, woodland and wildlife; engineering and roadside erosion control operations; nursery stock and seed furnished for agronomic, woodland and wildlife activities; C. C. C. camp labor; water facilities planning; and surveys and plans for future effective erosion control and land management.

Significant research work at the Service experiment stations is reported as involving studies in rotations, strip cropping and terraces, contour tillage, organic matter applications, soil erodibility, and soil moisture. Other research results, including climatic, physiographic, hydrologic and sedimentation studies and hillculture, drainage and irrigation investigations, are reported as having considerable influence on plans for future operations. Economic investigations, and evaluation studies and field tests as carried on with the cooperation of State agricultural experiment stations, are pointed out as leading to conclusions of importance regarding soil and water conservation practices and crop yields.

Submarginal-land purchase and development is discussed as tentatively planned for land-use adaptations and farm family rehabilitation.

The report closes with a résumé of the surveys and mapping as carried out during the year, and a detailed account of the activities of the information and education division.

NOTES ON INFILTRATION PROBLEM

(Continued from p. 234)

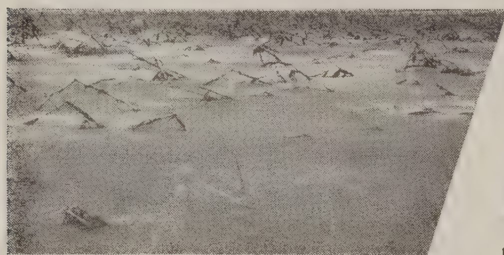
filtration. In test after test it has been found that a type of land use favoring the retention of organic matter in the soil has associated with it a soil structure in which the pores of the soil are relatively large—the individual soil particles being aggregated—and with these conditions there is found high infiltration. Soils having like conditions of silt, clay, colloid, and other constituents but which have been subjected to intensive agriculture, with resulting exhaustion of organic matter, destroyed soil aggregates and the consequent increase in density of structure, mostly have lower infiltration rates than their counterparts which have been well managed.

The effect of a surface mulch in providing a favorable structure where the water first enters the soil has been shown by Duley and Kelly.[3] Many workers in our Service are directly concerned with the advancement of our knowledge of infiltration; and technical workers of many agencies outside the Service appreciate its importance and in numerous instances are directly concerned in the advancement of its special phases. Th next few months doubtless will see a number of important technical papers that will be of interest and assistance to all of us.

[3] Duley, F. L. and L. L. Kelly: Effect of Soil Type, Slope, and Surface Conditions on Intake of Water. Res. Bull. 112. Agricultural Experiment Station, Univ. of Nebraska. May 1939.

FLOOD CONTROL MEASURES ARE CONSERVATION MEASURES

Inundated street in Lindsborg, Kansas. The result of backwater from Smoky Hill River.



Sand deposit left on valuable cropland in Crittenden County, Ky., by Ohio River flood in January 1937

Deposit of silt and debris from Walton Hollow after a flood in 1932, McGregor, Iowa.

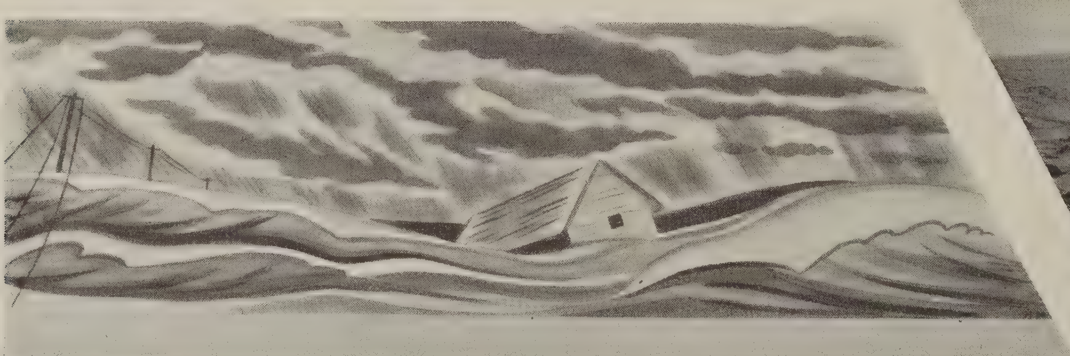
High water on Liberty Street, Bath, N.Y., during a July flood.

Clean streets in McGregor during 1938 flood. A happy result from the application of conservation measures on the watershed and the construction of the Walton Hollow detention reservoir.

Water standing in contour lister ridges in Oklahoma field after a heavy downpour.

Valley City dam project in Barnes County, North Dakota. It was built in 1935.

Streambank control of timber and stone with culvert drain, protecting a highway near Sparta, Wisconsin.



The Canadian River goes out of its bounds in Hemphill County, Texas, October 1935.

U. S. GOVERNMENT PRINTING OFFICE: 1940

Precipitation and Soil Fertility Studies Among New Publications

For REFERENCE

Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Engineering Handbook. Section 2: Specifications for Recommended Building Practices. SCS-ED-3b. December 1939. mm.[1]

Land Saving Plans for Conservation in the Pacific Southwest. Soil Conservation Service, Regional Office, Berkeley, Calif.

Precipitation in the Muskingum River Basin, October 1939. SCS-TT-24. December 1939. mm.[1]

Precipitation in the Muskingum River Basin, November 1939. SCS-TT-25. January 1940. mm.[1]

Office of Information U. S. Department of Agriculture

The Annual Lespedezas as Forage and Soil-Conserving Crops. Circular No. 536. Contribution from Soil Conservation Service and Bureau of Plant Industry. November 1939.

Bacterial Wilt of Lespedeza. Technical Bulletin No. 704. Bureau of Plant Industry. November 1939.

The Farm Real Estate Situation, 1936–37, 1937–38, and 1938–39. Circular No. 548. Bureau of Agricultural Economics. October 1939.

Lespedeza Sericea and Other Perennial Lespedezas for Forage and Soil Conservation. Circular No. 534. Contribution from Soil Conservation Service and Bureau of Plant Industry. November 1939.

Protecting Field Borders. Leaflet No. 188. Soil Conservation Service December 1939.

Soybeans: Culture and Varieties. Farmers' Bulletin No. 1520. Bureau of Plant Industry. Revised November 1939.

Sweet Clover. Leaflet No. 23. Bureau of Plant Industry. Revised October 1939.

Taming Our Forests. Forest Service. Slightly Revised August 1939.

Agricultural Experiment Stations

Composition, Rating, and Conservation of Willamette Valley Soils. Station Bulletin No. 365. Oregon Agricultural Experiment Station, Corvallis, Ore., with cooperation of Works Progress Administration. July 1939.

Cost and Efficiency in Producing Hops in Oregon. Station Bulletin No. 364. Agricultural Experiment Station, Corvallis, Oreg. June 1939.

Economic Conditions and Problems of Agriculture in the Yakima Valley, Washington: The Agriculture and Its Setting. Bulletin No. 377. Agricultural Experiment Station, Pullman, Wash. July 1939.

Fertilizer and Liming Practices Recommended for South Carolina. Circular No. 60. Agricultural Experiment Station, Clemson, S. C. October 1939.

Fertilizer Problems and Analysis of Soils in California. Circular No 317. Agricultural Experiment Station, Berkeley, Calif. Revised November 1939.

Haying in the Rain: A Study of Grass Silage. Bulletin No. 362. Agricultural Experiment Station, Amherst, Mass. April 1939.

Relationship of Productivity of Farm Units and Their Ability to Pay Rent. Research Bulletin No. 308. Agricultural Experiment Station, Columbia, Mo. November 1939.

Seasonal Water and Nitrate Leachings in Relation to Soil and Source of Fertilizer Nitrogen: A Second Report on Windsor Lysimeter Series "A." Bulletin 429. Agricultural Experiment Station, New Haven, Conn. October 1939.

Small Grain Production In The Yazoo-Mississippi Delta. Bulletin No. 334. Agricultural Experiment Station, State College, Miss. September 1939.

Soybean Production in Kansas. Bulletin 282. Agricultural Experiment Station, Manhattan, Kansas. March 1939.

A Study of Farming in the Sandy Creek Soil Conservation Demonstration Area: With Special Reference to Erosion Control. Bulletin No. 203. Agricultural Experiment Station, Experiment, Ga. November 1939.

Use of Fertilizers and Lime on Native Pastures in Michigan. Technical Bulletin No. 167. Agricultural Experiment Station, East Lansing, Mich. November 1939.

The Value of Irrigated Pastures for Dairy Cattle. Station Bulletin No. 366. Agricultural Experiment Station, Corvallis, Oreg. September 1939.

The Value of Legumes for Soil Improvement. Bulletin No. 336. Agricultural Experiment Station, State College, Miss. August 1939.

Woodlands of Kansas. Bulletin No. 285. Agricultural Experiment Station, Manhattan, Kansas. July 1939.

A Year's Progress in Solving Farm Problems of Illinois, 1936–37. Annual Report for year ended June 30, 1937. Agricultural Experiment Station, Urbana, Ill. October 1939.

Miscellaneous

Collecting and Handling Seeds of Wild Plants. Civilian Conservation Corps. Forestry Publication No. 5. May 1939

The Cutover Region of Wisconsin: A Report of Conditions and Recommendations for Rehabilitation. Bulletin No. 7. Wisconsin State Planning Board, Madison, Wis. January 1939.

Farmer's Irrigation Guide. Conservation Bulletin No. 2. Bureau of Reclamation, U. S. Department of the Interior. 1939.

Federal Relations to Local Planning. Circular XIV. Executive Office of the President, National Resources Planning Board. December 15, 1939. mm.

Rebuilding Wheat Lands With Grasses and Legumes. Extension Circular No. 28. Extension Service, Pullman, Wash. April 1939.

Summary of Outstanding Laws Affecting Rural Land Use Enacted During 1939. (Primarily for the Information of Bureau of Agricultural Economics Personnel, Soil Conservation Service and Forest Service). Bulletin No. 51. U. S. Department of Agriculture. January 1940. mm.

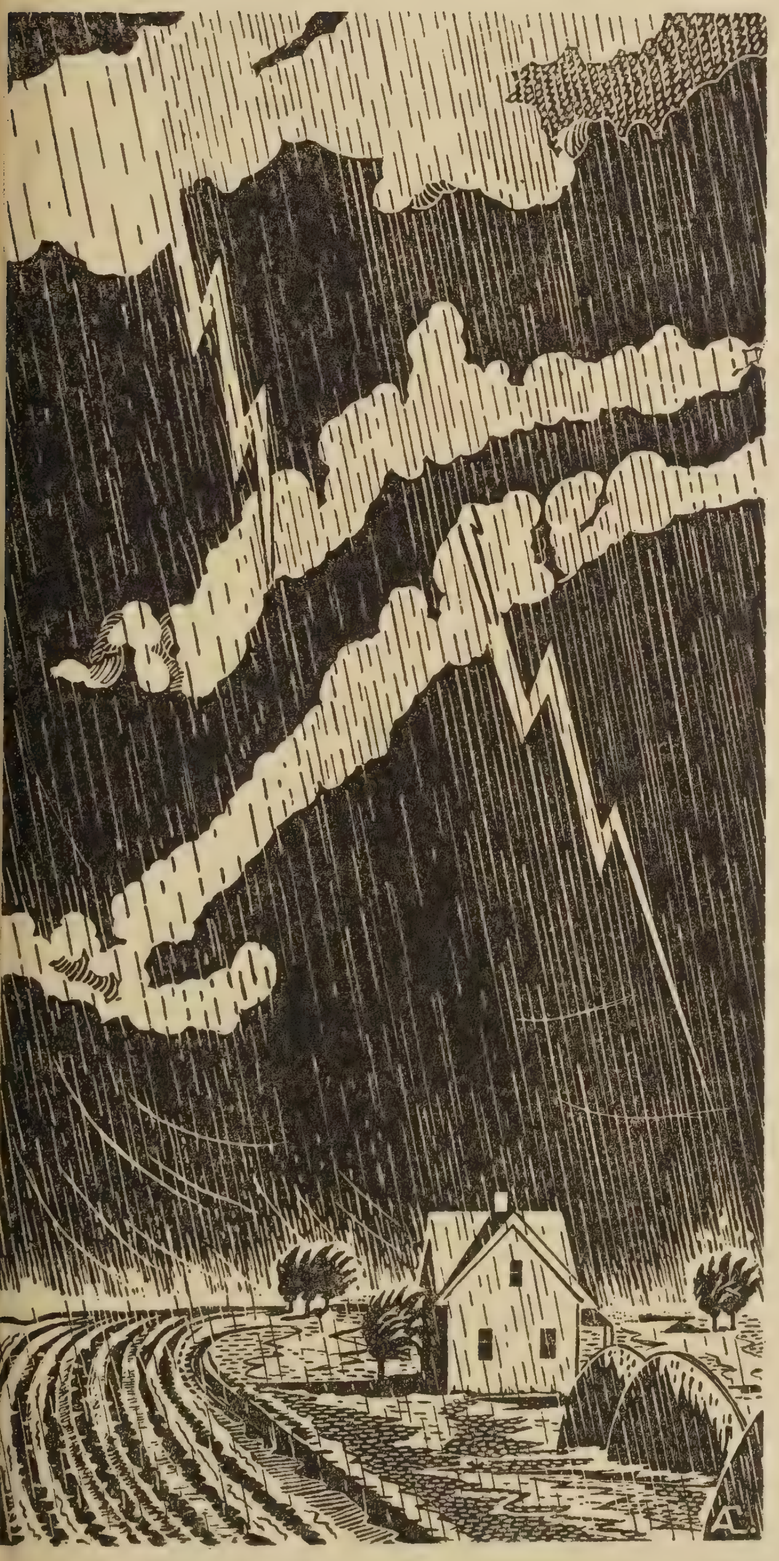
Use of Irrigation Water on Farm Crops. Publication 509, Farmers' Bulletin 10. Dominion Experimental Station, Lethbridge, Alberta, Canada. December 1939—Revision.

[1] Issued for use by Soil Conservation Service staff and cooperating offices only.

In Clatsop County, Oreg., pickets are used on beach dunes to create wind eddies which cause the settlement of the moving sands. The C.C.C. enrollees in this scene

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON



Special Issue
on
Pasture
Management

APRIL
1940

Contents

Front cover by Adrian Clem

Back cover by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL, PLANT, AND LIVESTOCK RELATIONSHIPS

BY A. T. SEMPLE [1]

IN a recent article, W. A. Albrecht, chairman of the Soils Department, University of Missouri, and recently president of the Soil Science Society of America, has pointed out the dangers of depending upon depleted or "sick" soil for the production of forage for livestock. Such soils produce stunted plants that are deficient in essential nutrients such as minerals and proteins. Cows and other stock which must feed on such plants may suffer from deficiency diseases such as "grass tetany" the symptoms of which are similar to milk fever. In the course of robbing their skeletons to produce young and rebuild the bones, deformities develop which may affect the gait.

Doctor Albrecht cites an instance wherein the "analyses of herbage which had defaulted in its support of a cow . . . showed a calcium content of but 0.27 percent and a phosphorus composition of only 0.08 percent. Ordinary wheat straw has 0.21 percent of the former and 0.12 percent of the latter." The herbage consisted of grass with a sprinkling of lespedeza. This illustrates the starvation diet discussed by Moorish in this issue of SOIL CONSERVATION. Usually, in such instances, a mixture of plants such as grasses and legumes provides somewhat better feed than grasses or weeds alone.

In Minnesota, work of Professor Eckles and colleagues showed that cows suffered from "phosphorous deficiencies" when the phosphorous content of alfalfa hay dropped to 0.21; timothy hay to 0.11; and prairie hay to 0.10. The calcium content of these hays respectively was 1.81, 0.39, and 0.44 percent.

In remedying such conditions, it should be kept in mind that the application of the deficient minerals to the soil enables the plants to grow faster, produce more leaves, and yield more forage. In one instance, Dr. Albrecht points out, the application of limestone to lespedeza increased the lime content of the hay almost one-fifth, the phosphorous content one-fifth, and the protein content one-fourth, in addition to the increase in the total yield of dry matter.

Dr. Albrecht concludes in part as follows: "That sick soils will not make healthy animals is particularly significant at this time. We are thinking on a national scale of combating soil erosion by allowing much of the fertility-depleted soil to go back to grass. In our desperate search for varieties of plants that will exist on such soils, perhaps we have given too little thought to whether the forage so grown would be put by the cow on her list of dietary delicacies. . . . Attention to the evidence of soil deficiencies as given by the dumb animals will react with profit both individually and nationally."

The introduction of a plant that will grow on barren sheet-washed slopes, wind-swept fields, and raw gullies, or that will thicken the stand to increase cover and improve forage value of poor, weedy grasses on "sick" soil, often is a necessary measure both ecologically and financially in controlling erosion on critical areas, and is likewise a step in the direction of better land use.

Obviously there is no possibility of satisfactory returns from livestock suffering from deficiency diseases. Where the cost of establishing and maintaining adequate plant food in the soil is prohibitive mineral supplements should be fed to help in warding off deficiency diseases. This practice often is advisable also on soils of low fertility that are in the process of being built up.

The profit to be derived from improved levels of fertility is amply demonstrated on a badly eroded and formerly tax-delinquent field abandoned to briers, at the Western Kentucky Experiment Substation at Princeton. The field was treated with an application of 1½ tons of limestone and 600 pounds of superphosphate and seeded. Over a 10-year period the cash outlay for lime phosphate and seed amounts to about $1.50 per acre per year. The cattle gains have averaged about 80 pounds per acre more on the improved than on the unimproved land. At 5 cents a pound the increased return amounts to $4 per acre per year.

[1] Head, pasture section, division of agronomy, Soil Conservation Service, Washington, D. C.

215601—40——1

The pioneer farmer faced a landscape of prairie grass or other native vegetation from which to carve the farms of the Nation.

(See Mr. Kell's article beginning on the page opposite.)

Fifty years later the landscape changed. Not an acre of grass was left on many farms.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 10 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON APRIL • 1940

PASTURE IN RELATION TO CROPLAND

BY WALTER V. KELL [1]

IT was a relentless task, one long to be remembered, to tame the "wild prairie." No problem of grass then.

The task was started, the area of cultivated land grew and expanded to include almost every acre of plowable land. What appeared to be the problem at that time was solved and the plow had won. No sooner was the grass gone than the winds began moving, destroying, and drying out the mellow rich earth. Rains that fell on the bare ground were denied entrance into the soil; the water ran off, carrying with it the prize the plow had won.

Today one of the major tasks confronting the Soil Conservation Service is that of developing practical and economical methods by which a part of this land may be returned to the grass that once gave the soil its original structure and productiveness, grass to make and hold the soil and to provide profitable feed for livestock. This new problem is far more important and difficult than the first and its solution depends on a variety of factors. Climatic stability, seasonable rainfall, water supply for domestic and livestock use, physical and chemical characteristics of the soil, topography, location with reference to markets, density of population, economic pressure, the desire to make the farm a permanent place to live rather than a place from which to retire at the earliest opportunity—all these are important influences related to the solution.

People cannot live on grass alone, neither can they survive on a depleted soil, nor has any extensive area ever established a satisfactory agriculture on a system that is wholly a cash-crop system. To ensure permanently an abundant supply of the necessities of life requires the production of both cultivated crops and grass or pasture. The amount of each, or the balance that should be maintained between pasture and cultivated land, is the problem. It varies by area. Only a few short years ago the pioneer farmers, some of whom are still here, had the problem of subduing the native vegetation for the preparation of cropland. The soil was fertile and the grass was persistent.

Pasture, whether too much or too little in relation to cropland, has always been and probably will continue to be a problem on the individual farm. Especially is this true when it is the policy of the individual or society to exploit virgin soil fertility by producing those crops that manufacture it into marketable products as rapidly as possible without regard for the future. Cash grain crops and their attendant physical loss of soil by erosion deplete the plant-food resources rapidly; grass, on the other hand, not only holds the soil but also maintains and restores its fertility.

Pasture is a farm crop; it produces a good or poor return, as compared with the other crops, in proportion to the interest and attention it receives. Too often the average farmer does not select land for pasture but uses whatever is left after providing for the other farm crops. The best farm land is now productive because nature kept it in permanent wildlife pasture before other crops were grown. Grass, as any other crop, responds to favorable conditions and fertile soil. In the past it has been the greatest of soil builders and it will continue to restore and maintain the fertility of all potential productive cropland if given an opportunity. Usually there is some land on the average farm that cannot or should not be used for cultivated crops but can best be adapted for permanent pastures.

[1] Senior agronomist, Northern Great Plains Region, Soil Conservation Service, Lincoln, Nebr.

There is danger of forgetting that grass is largely responsible for making the cropland productive. The farmer who will plan a long-time grass rotation, to permit all of his land to rest part of the time while it is seeded to grass and used for pasture, can maintain soil fertility more easily and effectively than the farmer who attempts continuous cash-crop production.

How does pasture, or the growing of grass, function in building soil? In the first place the soil must be stabilized and held in place before it can accumulate and retain fertility. It has been repeatedly shown that grass is one of the best soil stabilizers we have. At Zanesville, Ohio, the Soil Conservation Service experiment station found that bare ground in corn or fallow lost from 35.2 to 42.5 percent of the total rainfall, while bluegrass lost only 4.5 percent. It is interesting to note that the grass made possible the infiltration of practically all the rainfall. This fact, however, is not nearly so important as is the "holding power" of bluegrass or other grasses. Land in continuous corn, at this station, lost *59.6 tons* of soil per acre per year as a result of run-off, whereas grass lost only *100 pounds* of soil per acre. On the above basis the 7 inches of fertile topsoil, if planted to corn each year, would be completely gone in 19 years; and on the other hand, were the same land kept in bluegrass 23,200 years would pass before the same amount of soil would be lost. These results were obtained on a 12-percent slope in an area that received 34.5 inches of rainfall per year; such results show how grass holds the soil.

At Bethany, Mo., the Soil Conservation Service experiment station obtained similar results: Over a 5-year period having an average of 34.8 inches of rainfall per year, Shelby loam soil with a slope of 8 percent lost 31.2 percent of the total rain from bare ground and 9.2 percent from land that was protected by bluegrass and timothy. This run-off carried with it 112.8 tons of soil per acre from the bare ground and only 0.29 ton per acre from the soil protected by grass.

These factors have to do only with the physical maintenance of the soil. While this is essential if land is to be farmed continuously there is another function of the grass which makes it doubly valuable. Grass forms a dense vegetative cover for the soil, thus encouraging infiltration of moisture and development of bacterial life, and protecting it from some of the devastating weather conditions. At the same time grass sends out an enormous growth of very fine fibrous roots which penetrate the soil to a depth of several feet. Far greater tonnage of organic matter is supplied to the soil by grass roots than by its top growth. The undisturbed roots constitute a much more stable form of organic matter as they break down by oxidation less rapidly than organic matter or vegetation on the surface of the soil. While most of the root system for the normal pasture grasses is within the surface 6 to 10 inches, yet under many conditions grass roots extend 5 to 7 feet below the surface.

The character of growth of these roots is extremely important. They are very fine and have the ability to penetrate into many more of the soil pores than other vegetation. Because of their habit of fine root growth they are continuously sloughing off and sending out new growth further to fill the soil with organic matter in the form of tiny threads which bind the soil together. The roots of the ordinary pasture grasses, being high in carbon, resist decay and supply a stable form of organic matter. Soil filled with this type of organic matter not only will resist erosion and absorb and hold more water but will possess also that quality much discussed and little understood, called "good soil structure." The final break-down of this organic matter forms relatively large quantities of organic acids that act on the mineral constituents of the soil and facilitate those processes producing a fertile soil—an essential factor in stabilizing agriculture.

The highly specialized one-crop farm is gradually passing with the disappearance of virgin land. As long as the new soils were highly productive almost any kind of farming would provide enough products to supply the average family plus some for the market. In the Great Plains there are still some areas with sufficient fertility, preserved as a result of limited rainfall, to permit continuation of the one-crop system. In most of these areas physical soil losses due to wind or water erosion required adjustment in the one-crop practice long before the supply of virgin plant food was exhausted. Regardless of whether the specialized farmer was producing cotton, corn, or wheat, he frequently experienced periods of depression due to crop failure resulting from weather conditions, insect pests, or low prices. The production of one crop causes peak labor loads and the minimum of productive workdays. If the crop fails, practically all expense involved in the production of the crop continues.

With only part of the farm in cash crops and some of it in pasture, which for best utilization requires the keeping of livestock, many of these hazards are eliminated. Many farmers make profits and provide a portion of their living by feeding livestock in the winter when their time cannot be employed profitably in the field. By maintaining livestock, crop residues and immature crops which otherwise would be a loss can be converted into salable products.

Recently an agricultural worker, traveling through the farming region of the Great Plains, had occasion to stop for dinner at a number of farm homes. Most of these farms had been severely affected by adverse weather conditions. He observed that the type of farming being followed was reflected on the dinner table. The cash-crop farmer under adverse conditions is not now enjoying the same living standards as the man who has a diversified system with a few cows, a small flock of poultry and a variety of crops. The diversified farmer is still living fairly well and is less discouraged than the man who "put all his eggs in one basket" and "stubbed his toe" on the weather.

Pasture is very closely associated with diversified farming. Feed can be produced less expensively from pasture than in any other form. Studies on market milk by the United States Department of Agriculture, in 7 districts, disclosed that pastures furnished nearly one-third the feed for the cows at only one-seventh the total feed cost. Records show that on 478 Corn Belt farms producing beef calves the breeding herd obtained practically an entire living from pasture for 200 days, and roughage and concentrates for 165 days. The pastures, which furnished over half the feed, were credited with only one-third of the feed cost. At Beltsville, Md., experiments show that digestible nutrients in grass cost $0.48 per 100 pounds, while in corn silage and alfalfa they cost $1.22 per 100 pounds on the same or comparable lands. Kansas cost studies show that corn yielding 20 bushels per acre produced digestible nutrients at a cost of $0.643 per 100 pounds, alfalfa yielding 2.5 tons per acre cost $0.258, and tame pasture yielding 2.0 tons per acre cost $0.104. In other words, the cost of 100 pounds of digestible nutrients from tame pasture was one-sixth of that of corn. As a result of the pasture and livestock the farmer has a double opportunity of selling part of his crops for cash or of using it for livestock feed. This makes it possible to take advantage of favorable price situations and make minor adjustments in the system to provide the highest income.

One farmer living in the Shue Creek area near Huron, S. Dak., farming about 300 acres of his own land and renting one section of school land, made the statement that all the profits from his operations had been derived from the livestock which were produced on the section of leased school land. This not only had supplied his living but had made up part of the deficit incurred on his own 300 acres.

Mr. Davis, living near Poplar, about 30 miles west of Culbertson, Mont., was one of those optimistic farmers who planned to grow wheat in an area of very limited rainfall. He produced a very profitable crop in 1928 and has been trying since that time to duplicate it, but thus far he has failed. He was asked, "When did the farmers of the community enjoy the most stable income with the least worry?" His answer was, "When they had 25 or more cows, raised a limited acreage of cash crops, and had more than one thing on which to depend for their living." Then they usually had a few calves or a cow with which to pay taxes and supply meat for the table, but since the unusual drought the feed supply has become exhausted and it has been necessary to dispose of their livestock. They think now that it is necessary to regain the "backlog" of security in the form of a few livestock and a more diversified system. When weather conditions are favorable and prices are high there is a great deal of satisfaction in producing the maximum of one specialized crop. Usually these high income crops are accompanied by high production costs, and if the crop fails the loss is great. While the direct returns from pasture land may not be so great as from cropland, yet the production costs are correspondingly low and the resulting net profit may be even greater than from high-cost crops. The farmer who gives attention to his pasture land can sometimes make it the most profitable of any on his farm.

Livestock provides an opportunity for the farmer to process his farm crops, keeping the fertility on the farm instead of selling all raw material.

At Bridgeport, Nebr., H. Nagel is tenant-operator on a 240-acre farm. Part of this farm is under irrigation, part is used for dry-land agriculture and part is pasture. Fifty acres of wet alkali land used for pasture produced only saltgrass of very low feeding value. Mr. Nagel decided to improve the pasture by seeding it to strawberry clover. He purchased one pound of seed in 1936 and planted it in beds 4 feet square scattered at wide intervals over the 50 acres. His seeding process consisted of spading up the areas, leveling them down with a rake, using a scant tea-

There are no harvesting costs in this supplemental pasture which is used to relieve the pressure on the permanent pasture during the midsummer dormant season.

spoonful of the seed on each area and covering it lightly with a rake. He then laid down two fence posts and made a lattice work of lath to protect the new planting from livestock. In 1937 he bought two additional pounds of strawberry clover seed at $8 a pound and continued establishing additional areas over the 50 acres. This seeding was done in much the same way as the first. The area was used continuously for pasture and after the plants were established the posts and lattice were removed. In 1939 he had a good stand of strawberry clover over practically the entire area. That spring he turned 90 head of yearling steers on to this pasture and left them all summer. The strawberry clover provided feed for more than 6 months. The steers were weighed, in and out of the pasture, and the total gain for the 50 acres was 27,000 pounds of beef. The only additional feed supplied was a little grain during the last 10 days before the steers were taken off the pasture in preparation for full feed in the dry lot. In addition to the 27,000 pounds of beef, 368 pounds of clover seed, in the bur, were harvested from this area after the pasture season.

While this is an unusual situation, it illustrates what can be done by giving careful thought to proper land use. At the Huntley, Mont., Dry Land Experiment Station, pasture crops are grown under irrigation and are harvested by various classes of livestock. The dairy herd has produced from $40 to $60 worth of dairy products per acre per year—an achievement difficult to attain with cash grain crops.

Pasture, as any other crop, must be adapted to its environment and to the needs of the farmer. The proportion of pasture to crops on the average farm should be determined by two factors: First, the amount of time the land should be in grass to ensure soil stability and productiveness; and, second, the amount of pasture required to provide a balance with cultivated feed crops so that livestock can be profitably maintained throughout the year.

In areas with fertile soil and sufficient rainfall, tame or introduced grasses and forage plants usually produce more abundant pastures than native vegetation. Bluegrass and wild white clover, or smooth bromegrass and alfalfa, are excellent combinations and produce high-type pastures. In areas with limited rainfall, especially where droughts are prevalent, the hardy native grasses and wild legumes are more dependable and if carefully managed usually will survive the adverse moisture conditions.

When moisture is not the limiting factor in grass production then plant food, usually phosphorous, is the element limiting the volume of growth. Given an ample supply of phosphorous, legume plants are stimulated and they in turn will provide a surplus of nitrogen for the grass.

Tame or native grass can be maintained either for permanent pasture or for rotation pasture. By rotating the pasture with the cultivated land, erosion will be reduced to a minimum and the supply of organic matter in the soil will be more easily maintained. Many of the recent farm difficulties, aggravated by erosion, floods, droughts, price-depressing surpluses, pests, etc., could be averted were enough grass provided on each farm so that plowing would rarely be done except in sod. The rotation would be row crops, small grain, hay, pasture. This type of rotation is a radical departure from common practice and may be criticized; but rarely if ever has the fertility of the soil been depleted, or the general farmer gone bankrupt, because of too much hay and grass. A survey in southern Indiana indicated that those farmers with one-half of their land in pasture and one-half in crops made more money than those with one-fourth pasture and three-fourths crops. On these farms 36 percent of the total feed for dairy herds was produced from pastures which furnished nutrients at one-fourth the cost of nutrients in harvested crops.

In areas of limited rainfall the proportion of pasture to cropland should be much larger than in humid areas. This proportion will vary from one-fourth pasture and three-fourths crops to one-fourth crops and three-fourths pasture. In areas where one-half to three-fourths of the land should be in grass the croping unit probably should be from 160 to 240 acres with 600 to 1,000 acres of pasture land. In an extensive system of farming this sized unit should provide under normal conditions a fairly comfortable living for one family.

In the large transitional area of the Great Plains where the Corn Belt and general farming merge into

(*Continued on p. 258*)

A GRAZING PROGRAM FOR SOIL CONSERVATION IN THE SOUTHEAST

BY R. Y. BAILEY [1]

FOR generations southeastern farmers have plowed and hoed grass out of row crops and sold these crops to buy meat and other supplies that could have been produced at home. But of recent years there has been a gradual change from crop farming to a more general type of agriculture whereby farm income is derived from both crops and livestock. This change is converting the present generation of grass fighters into grass growers. Farmers who are increasing their livestock are finding that it is about as difficult to keep plenty of grass in their pastures as it is to keep it out of their crops. Those who are trying to supplement both their food supply and their cash income by growing more livestock are finding that good pastures are essential to the success of this enterprise. Unless a sound grazing program can be developed, this new livestock venture is doomed to failure.

Although certain factors, such as mild winters, high annual rainfall, and a long growing season, are favorable to pasture development in the Southeast, there are serious disadvantages also. Chief among the latter are poor soils and uneven distribution of rainfall.

Most of the soils in the Southeast were not rich when first cleared. A large proportion of the land now available for pastures has been devoted to the production of clean-tilled row crops for so long that it has lost most of its topsoil by erosion. As a result of this severe erosion, much of this land is now so poor that it will not produce as much as 10 bushels of corn to the acre. These eroded soils have a low water-holding capacity and the result is that pasture plants suffer from drought. With the exception of the lowland areas along streams and in natural depressions most of the land available is too dry for good pasture.

The uneven distribution of rainfall causes widely varying amounts of feed to be available in pastures during different periods of the grazing season. In periods of high rainfall, in July and early August, a permanent pasture may furnish more feed than the animals can consume, while on the other hand by the end of August the grass may be suffering because of drought. Over a period of less than 1 month the carrying capacity of a pasture may vary by more than 50 percent. This condition makes it extremely difficult to maintain an even distribution of grass throughout the growing season where permanent pasture alone is depended upon. If pasture acreage is large enough to ensure plenty of grass during dry periods there will be an excess during favorable periods, with the result that the pasture will be undergrazed and the quality of the grass will deteriorate. If, on the other hand, the acreage of permanent pasture is reduced to that necessary to provide enough grazing during favorable periods, then pastures will be overgrazed during dry periods, the sod will be injured, and animals will not get enough feed. It is obvious that the animals cannot adjust their feed needs to seasonal conditions; they must have plenty of feed during the entire grazing period if they are to make satisfactory gains.

An effective grazing program, to ensure plenty of feed during the entire grazing season and at the same time to make the best possible use of grazing land, will require careful planning. The problem might be approached by establishing a sufficient acreage of permanent pasture to carry the livestock through favorable periods, and supplementing this during unfavorable periods with hay grown on other land. This plan would be objectionable, however, because of the labor and other expense involved in growing, harvesting, and storing hay. Another approach to the problem is the use of special crops for temporary grazing during unfavorable periods. Such crops may be divided into two general classes—annuals and perennials. Such annuals as Sudan grass, soybeans, and cowpeas furnish good grazing when they are available, but their use is not always feasible because of the labor required for planting and, in the case of soybeans, for cultivation.

Unfortunately, conditions that reduce the growth of plants in permanent pastures also are unfavorable for these annuals and as a result these crops may fail at a time when they are most needed. Annual lespedeza is probably the best of all annual crops for temporary or periodic grazing. Much of the hilly land used for pasture is not suitable for the production of the more desirable pasture grasses, but such land, where the soils are moderately heavy, will grow annual lespedeza, particularly if an application of phosphate is made. On the sandy soils of the Coastal Plains, annual lespedeza suffers from drought and is

[1] Regional agronomist, Southeastern Region, Soil Conservation Service, Spartanburg, S. C.

White clover is furnishing plenty of early spring grazing in this Mississippi pasture.

less dependable than such deep-rooted perennials as kudzu and *Lespedeza sericea*.

Of the perennials that are adapted on most of the soils in the Southeast, *Lespedeza sericea* and kudzu offer the greatest possibilities for use as temporary grazing crops. There is a general opinion that animals will not graze *Lespedeza sericea*. It has been found, however, in a number of places, that if animals are turned on *L. sericea* early in the spring when the plants are tender they will graze it quite readily. In fact, results from grazing *L. sericea* have been very encouraging.

Kudzu has been used rather extensively as a temporary grazing crop for late fall on farms on Soil Conservation Service demonstration projects and C. C. C. camp areas during the past 2 years. Both *Lespedeza sericea* and kudzu have the distinct advantage of growing well on hilly land where grasses and other pasture plants are seriously affected by drought. These plants have a further advantage in that they do not require annual plowing and planting as is necessary where annual forage crops are used for temporary grazing. This is an extremely important factor, as farmers who depend upon the annual forage crops frequently fail to get them planted at the proper time because they are busy with other crops.

A simple grazing program, to provide feed throughout the normal grazing period, should include (1) bermanent pasture on the lowland areas along streams and in natural depressions, (2) a sufficient acreage of *Lespedeza sericea* for spring grazing, (3) pure stands of annual lespedeza on suitable upland, and (4) a sufficient acreage of kudzu for grazing during the fall months when the grass and annual lespedeza are retarded by drought. On sandy soils where annual lespedeza does not grow well, it will be necessary to increase the acreage of kudzu sufficiently to provide grazing during dry periods in summer. Such an arrangement of grazing plants would ensure a supply of feed throughout the grazing period, whereas, if permanent pasture alone is depended upon there will be peaks of high production when there is an excess of feed, and periods of low production when there will be shortage. In analyzing a grazing program of this kind it may be noted that permanent pastures usually are good in early spring where white clover and hop clover are included in pasture mixtures. After these plants pass their peak of growth and mature their seed, however, there is a period of shortage of grazing because grass and annual lespedeza, which have been held back to some extent by the heavy stand of clover, have not come into full production.

Lespedeza sericea makes rapid growth immediately after killing frosts are over in the spring and will fill the gap between the winter clovers and the summer grasses. In sections where white clover does not grow well, it may be necessary to depend upon winter cover crops on cultivated land for late winter and early spring grazing. After the permanent pasture comes into full production, animals can be removed from the *Lespedeza sericea* so that it may be allowed to produce

(*Continued on p. 253*)

PROFITABLE PASTURES FOR THE OHIO VALLEY

BY R. H. MORRISH [1]

WE have failed rather generally to recognize fully the great importance of pasture land and the crop produced thereon in the management of farm land. In this respect, people in the Ohio Valley Region probably are not different from those in some other sections.

It is only within recent years that we have begun to realize the value of pasture as a crop that produces feed for livestock less expensively than this same feed can be produced with any other forage or grain crop. Along with this recognition of the economic value of good pasture, we are beginning to appreciate the effectiveness of good sod in holding soil losses to a minimum on sloping land. This growth of interest in the true value of pasture land results from facts established by a large number of practical experiments and observations made by farmers themselves.

The literal definition of pasture, often used, calls it "ground for the grazing of domestic animals." On too many farms in this region, pasture is in fact mere "ground"—bare or infested with weeds and unpalatable grasses, from which the topsoil has been lost by severe erosion.

From the viewpoint of the practical and successful livestock farmer, pasture might better be defined as "an area producing a maximum amount of highly nutritious forage at a time when it is most needed, so managed as to be able to maintain its productivity and its soil-conserving qualities." A considerable number of farmers in this region have been successful in establishing and maintaining profitable pastures; timely use of good cultural practices and sensible management constitute their formula.

The Soil Conservation Service in this region is only one of the several agencies emphasizing the importance of productive pasture in the farm plan. The first job in the promotion of a sound pasture program has been and will continue to be one of education requiring the best efforts of all agencies concerned. No amount of published information or pasture management plans written into cooperative agreements can take the place of personal contact and assistance to the farmer during the time that he is overhauling his pasture improvement and management scheme and establishing it as an integral part of his farming operations. More and more, farmers are looking on pasture as a crop worthy of treatment and management comparable to that accorded other crops grown on the farm.

As a result of a unified educational program a new concept of forage and pasture crop values is developing in the minds of farmers and agricultural workers alike, and there is a noticeable trend on some farms toward what might be termed a "grassland agriculture." These changes are being made slowly; but it is encouraging to note that the most neglected fields on many farms, now set aside for the grazing of livestock, are beginning to receive much needed attention and are responding satisfactorily. In the production of corn or tobacco, of cotton or small grain, farmers are able to evaluate yield increases in pounds, bushels, or bales, because they take an active part in the harvest operation. Pasture harvesting operations are done by the livestock which, in turn, offers tangible evidence of increase in meat, wool, or milk. But the evidence is often not so readily seen.

A number of rather serious difficulties have been encountered in the establishment of productive pasture on many farms. Designating an area of land as "pasture" on the basis of its land-use capability does not make it so. Altogether too much optimism has been present in the minds of many in thinking that an eroded tract of broomsedge and poverty grass can be turned into productive grazing land in only one or two growing seasons. These "vegetative skeletons," if not too far gone, can be brought back by following a prescription of rest, proper plant food, and careful treatment. Fortunately, comparatively few of the pastures in this region are in this completely worn-out condition.

Other difficulties encountered may be described as follows: (1) Most farms are overstocked on the basis of present carrying capacities; (2) fencing often is inadequate to provide necessary protection for the resting and renovating of old pastures; and, (3) winter grazing is an habitual practice in many areas where it is impractical and destructive. The failure and inadequacy of stock-water supplies, particularly during dry summer months, often is an added difficulty where rotational grazing should be followed.

[1] Chief, regional agronomy division, Ohio Valley Region, Soil Conservation Service, Dayton, Ohio.

215601—40——2

The farm of E. F. Humphrey, Grant County, Ky., is fenced to permit proper pasture management, including rotational grazing. Pasture field in foreground to left of fence has been grazed down to approximately 2 inches, and stock will soon be moved to pasture on right of fence where grass is now about 6 inches high. Contour tillage and contour fences are used where needed.

Any workable pasture management program must be a practical one that can and will be followed. It must be devised to fit the problems of the individual farm, at first perhaps on a limited scale, with sufficient provision for changes and improvements as progress is made. The initial plan for the establishment, improvement, and maintenance of good pasture may carry all the features of an ideal program, but it is often economically impossible to initiate all its phases without delay. The farmer may be unable to meet the entire financial obligation involved in purchasing lime, seed, and fertilizer, and in building necessary fences.

In this region, a specific plan for pasture improvement is being followed and is producing the desired results on many farms. Because of wide variations in climatic and soil conditions and in the adaptation of forage grasses and legumes, the treatment has been designed for general application and is modified, as needed, to fit individual farms. This program is based on at least six fundamental practices.

Feed your pasture and your livestock will be fed.—Adequate soil amendments in the form of lime and fertilizers must be applied, if worth-while results are to be obtained. Farmers ask, "Does it pay?" Their own observations and experiences are teaching them that if they feed pastures, livestock likewise will be fed.

Virgil Stipp of Lawrence County, Ind., together with several of his neighbors maintained records, during 1938 and 1939, of animal-unit days of grazing per acre on treated, untreated, and supplemental pastures on their farms. Mr. Stipp's records show that he received approximately 68 cow-days per acre per year from the treated pasture area, and only 29 from the untreated tract. "Pasture treatment pays on my farm" he observes, "and I am increasing the treated acreage as rapidly as I can."

Numerous farmers throughout the region are learning by doing, and they report successful results. C. M. Flege of Grant County, Ky., for example, attributes his success in livestock farming to his management practices. "If you want good pastures, rotate your grazing, use lime, mow the weeds, and keep growing legumes with the grass," he advises.

In the treatment of pasture land, blanket recommendations often are hazardous, since each area presents a different set of conditions as to requirements and past history. Nor do half measures serve to demonstrate effectively the value of such treatment.

In most instances the pasture area which will give the quickest and greatest returns for the work and money spent should be first to receive the necessary treatment. This approach enables the farmer to extend treatment to other areas of his land from which lesser returns may be expected, and also affords a better demonstration of the possibilities of pasture improvement.

Heavy grazing is an intensive type of farming, when one considers the amounts of plant food removed from the soil, and too often the mineral content of the forage which is closely related to the health and productivity of the animals is given insufficient consideration. If the calcium, phosphorus, and protein content of the herbage is low, it is possible that an animal is on a starvation diet. This fact is another good argument in favor of the economy and practicability of pasture treatment.

An empty stall pays better than a poor cow.—A tendency exists on the part of many farmers to overrate the present carrying capacities of their pasture areas. If success is to be attained in pasture improvement, it may become necessary to reduce temporarily the number of livestock during the period of establishment and renovation. E. G. Meeks, a livestock farmer in northern Kentucky, sold a flock of sheep as an important step in initiating his plan for better pastures. He later replaced them, and has increased his livestock population progressively over the original number. His satisfaction is expressed thus: "My pasture fields are now worth $5 more per acre, on the average, due to the rest from grazing."

Membership in a dairy herd improvement association has helped many farmers to reduce the number of animal units without reducing returns from livestock products. A Michigan dairyman made the following sage observation relative to benefits derived in this manner: "I have learned that an empty stall will make me more money than a poor cow."

Average pastures in the Ohio Valley Region can be so managed that they will carry more units of livestock than now exist on them, but not if they are overgrazed and mismanaged—not even with adequate treatment.

Stock in the shed saves sod in the field.—Winter grazing is a habit, and one that is inadvisable from the standpoint of production except in certain sections in the southern part of this region. After the first killing frost in the fall the food nutrients contained in most pasture forage are extremely low and, although there may be a bulk of forage in evidence, its feeding value is not comparable to good hay. In addition, winter grazing results in the destruction of the turf and promotes weed growth and soil erosion. To change this habit, it is necessary to provide legume-grass hay and, perhaps, corn or hay crop silage. This, in turn, permits barn or shed feeding and maintains production at fairly high levels.

Permanent pastures need some help.—In those parts of the region where dependence is placed on permanent bluegrass pastures, it is fundamental that other types of grazing be provided during the midsummer when permanent pastures are least productive. In all probability, the best type is a mixture of drought-resistant legumes and grasses, such as alfalfa and smooth bromegrass. Wheaton Hicks, a farmer in Livingston County, Mich., is using this combination for both hay and pasture, and reports his observations as follows: "Alfalfa-brome makes a good pasture. It furnishes feed of excellent quality during the hot summer months when bluegrass is dormant. The milk production of my herd was kept up during this period."

Sweetclover, Reed canary grass, and annual lespedezas, when properly managed, also offer possibilities for this use. If these crops, particularly alfalfa, are not well managed, a shortage of high-quality hay may result; and if grazed during critical periods in the fall, adequate recovery of root reserve may not be attained. Annual supplemental crops, such as Sudan grass and millet, may be needed, but as they require annual seedbed preparation they are expensive and erosion-inducing.

Give him stock water and his plan is complete.—Water supply is one requirement of a complete pasture program, the importance of which is often underestimated. Adequate and dependable water supplies must be provided if successful management and improvement, as well as economic livestock production, are to be secured. A farmer in southern Ohio remarked: "Now that I have a good, dependable water supply in the pond and a cement watering tank, I can really begin to accomplish something with my pasture improvement plans." During each of the three previous summers, he had found it necessary to haul water 3½ miles, which is just another way of saying that no one factor will upset the scheme so quickly or so completely as a dry year and corresponding failure of stock water supply.

The eye of the master fashions his sward.—Numerous management features, such as timely clipping, increase carrying capacities and the quality of the turf. For the most part, these practices are not burdensome and do not necessitate any considerable cash outlay.

(Continued on p. 250)

GRAZING MANAGEMENT FOR PERMANENT PASTURES IN CORN BELT AND NORTHEASTERN STATES

By M. A. HEIN [1]

FERTILITY is of the greatest importance in increasing pasture production, and a system of soil treatment is essential to accomplish this end. The most critical period for maintaining production is during the hot, dry summer months. Under these conditions fertilizers, particularly nitrogenous fertilizers, fail to maintain production equal to that of spring and fall periods. In this summer period, when annual crops require attention, management of permanent pastures by certain grazing practices must be followed. Even the best permanent pastures rarely produce half as much forage during July and August as they do during May and June.

To ensure sufficient pasture during the critical summer months, one of several methods of grazing management may be followed. If permanent pastures are intended to supply feed throughout the entire season, sufficient acreage should be available to provide adequate forage during seasons of minimum production. This may be accomplished by deferring the grazing on certain areas until midsummer so that the herbage will contain a large percentage of mature grass that is low in protein and high in crude fiber. Certain legumes naturally will be a part of such a mixture, and they in combination with some of the immature grass leaves will make the herbage sufficiently high in nutritive value to furnish forage that will maintain beef cattle. There is some question as to whether or not such pasturage has enough nutritive value for milk cows; it is certain, however, that such pasturage is superior in quantity to that obtained from permanent pasture that has been closely grazed in the spring and early summer with no reserve feed for the dry summer months.

If there is an excess of permanent pasture during spring months, the growth may be removed either as hay or silage for supplementary feed during the summer or winter months. It should be removed early in the season in order that the plants may attain sufficient growth before drought periods. Such management will not suppress the white clover, as the excess grass is removed while the clover is still growing and there is usually enough rainfall for its maintenance. In regions where annual lespedezas are adapted, the grass is removed while climatic conditions are favorable to the rapid establishment and growth of these legumes.

Rotation grazing of permanent pastures is excellent in theory for maximum utilization of herbage high in nutritive value. In general practice, however, it requires a larger number of animals during the early grazing season, for utilization of all herbage in its vegetative stage, than can be carried on the same area during the hot, dry months of summer. Again, in this system, excess spring growth may be removed as hay or silage if enough permanent pasture acreage is maintained to carry all animals during periods of minimum pasture production. When succulent forage is desired during summer months, usually some form of supplemental pasturage or barn feed should be provided even with a rotation system of grazing, unless moisture conditions are ideal throughout the growing season.

The ideal permanent pasture would be one that would carry the same number of animals throughout the entire growing season with forage at all times equally high in nutritive value. For the present, this goal has not been reached by any system of grazing management, fertilizer treatment, or by the use of proper combination pasture plant mixtures. Because of this it has been necessary to use supplemental or temporary pastures to maintain uniform production. Sudan grass and millet have long been used for emergency hay crops, and more recently Sudan grass has been widely used for pasture. Soybeans and sweetclover also have been used for similar purposes. Temporary crops requiring plowing and seedbed preparation add materially to labor costs and at the same time leave the soil without a cover so that it is subject to soil losses unless the land is level or so managed that such losses are controlled. The ideal supplemental pasture is one that requires the least labor for establishment, maintains continuous cover, and finally provides a maximum of forage.

In regions where Korean lespedeza is adapted it probably is the most ideal crop. It can be grown with

[1] Agronomist, division of forage crops and diseases, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

fall- or spring-seeded small grains. The cereal crop, removed either as grain, hay, or pasture, when interplanted with Korean lespedeza, furnishes an ideal soil cover until ready for grazing. For maximum production of Korean lespedeza, certain grazing management practices must be observed. The most important of these practices is to graze early and as closely as possible within reason. It has been observed that if rainfall is below average the lespedeza is more productive and makes much better cover under these practices than when allowed to attain considerable growth. The close grazing does not interfere with natural reseeding.

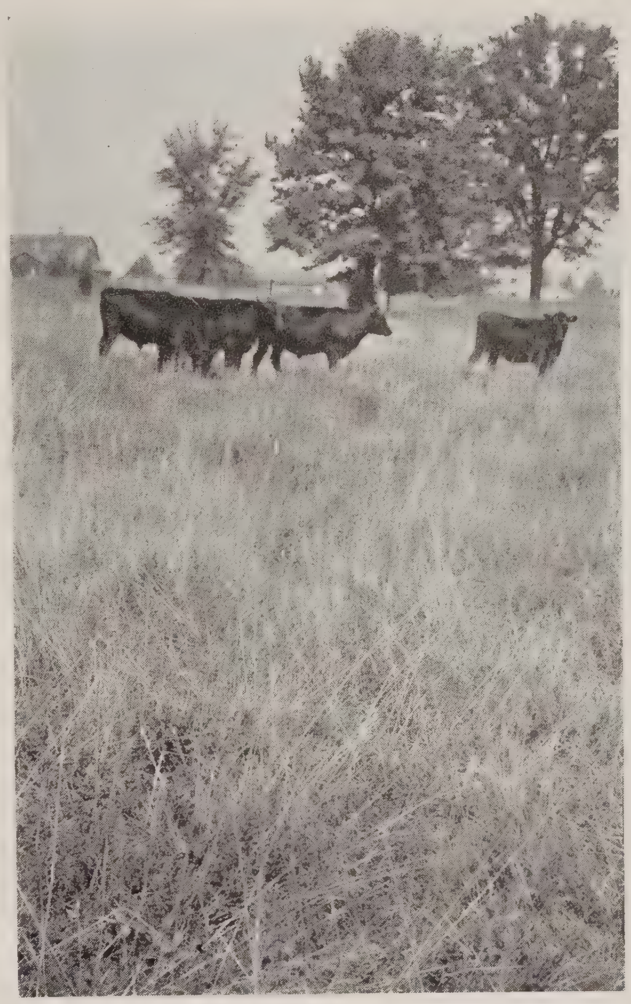
In regions where Korean lespedeza is not adapted, sweetclover may be used in a similar manner. A few farmers have followed the practice of seeding timothy with the sweetclover, contending that the timothy will furnish a bottom grass and a better mixture for grazing. Ladino clover also is used, but it is generally seeded as a permanent pasture. Ladino requires rather exacting soil fertility conditions as well as grazing management practices for maximum production and to maintain a stand.

The practice of using the hay aftermath for supplemental pasture is one which should be more widely employed. If the hay crop is removed early, excellent pasturage will be had during the summer. A combination of bromegrass and alfalfa, used for hay, provides ideal summer pasture and soil erosion control. The stand of alfalfa will not be injured if properly managed.

A full discussion of all the elements that enter into the complicated pasture problem, such as grazing-management requirements for permanent pasture and individual crops and for different classes of livestock and soil-erosion relations, cannot be given in this paper. Data obtained from a few experiments in recent years, however, will show in part the value of different systems of grazing management in attempts to increase pasture returns, and also the importance of grassland in agriculture.

The first experimental work in grazing-management practices for permanent pastures in the eastern United States was started at Blacksburg, Va., in 1908. This work included studies of different intensities of grazing as well as of alternate versus continuous grazing. The results showed only a slight difference, in favor of alternate grazing.

The division of forage crops and diseases, Bureau of Plant Industry, in cooperation with the animal husbandry division of the Bureau of Animal Industry, conducted grazing-management experiments at Beltsville, Md., from 1929 to 1934 inclusive. Under the



Growth of annual lespedeza in a permanent pasture, October 1933, after 5 years of continuous light grazing; Beltsville, Md.

conditions of these experiments no significant differences in steer gains per acre were found between pastures heavily grazed continuously or alternately. The six-year average gain per steer on the continuously heavily grazed pasture, at the rate of one steer per acre, was 196 pounds per acre as compared with 194 pounds per acre on pastures alternately and heavily grazed. Steers on continuously and lightly grazed pastures, grazed at the rate of one animal to 2 acres, made an average gain of 287 pounds per steer as compared to an average of 195 pounds per steer on the heavily grazed pastures. The gain per acre, however, under light grazing, was only 145 pounds. Under the light grazing, considerable surplus forage remained at the end of the regular grazing period, and during 2 years of the experiment this surplus forage was used for late fall pasturage by thin feeder steers. The steers on this pasture made an average additional gain of 43 pounds per acre. This system of utilizing surplus forage in late fall, to bring feeder cattle to full feed, may have considerable value.

The different rates of grazing had an important effect on the plant population. Canada bluegrass, timothy, orchard grass, and lespedeza predominated under light grazing, while Kentucky bluegrass and white clover predominated under heavy.

In another pasture experiment at Beltsville, Md., in cooperation with the Bureau of Dairy Industry, in which the Hohenheim system of pasture management was investigated, it was found that the Hohenheim system—rotation grazing with dairy cows and heifers—increased the yield of total digestible nutrients 10.4 percent over continuously grazed and fertilized pasture in similar manner. From these results it was concluded that a 10-percent increase from rotation grazing would not be sufficient to justify construction of permanent division fences and the provision of necessary shade and water in each pasture. It was also found that the heavy fertilizer treatments failed to improve carrying capacity throughout the grazing season.

At Sni-A-Bar Farm, Grain Valley, Mo., grazing management experiments have been in progress for a number of years, and here, in addition to comparing continuous and rotation grazing, a study has been made of supplementary pasture. Each unit of permanent pasture is 25 acres in size. The fields for rotation grazing are divided equally in three parts. The rotation-grazed plus supplemented pastures contain 10 additional acres upon which a wheat crop seeded with Korean lespedeza is grown. During the seasons of 1937 and 1938 very interesting results were obtained. The precipitation during the 1937 season totaled 31.6 inches or 6.4 inches below the average, while during the 1938 season rainfall was average, or approximately 37.8 inches. The live weight gains under continuous grazing in 1937 were 64.2 pounds per acre; rotation grazing, 71.8 pounds; and rotation-grazed plus supplemented grazing, 108 pounds. In 1938 gains per acre for continuous grazing were 154 pounds; rotation grazing, 169 pounds; rotation grazing plus supplemented, 166 pounds.

It was interesting to note, during the 1938 season, that the total gains on bluegrass in the rotation-grazed and supplemented pastures were 196 pounds per acre for the bluegrass and 91 pounds per acre from the lespedeza pasture. The supplemented bluegrass pasture was rotation grazed before and after grazing the lespedeza. The 10-acre field of lespedeza, in addition to giving a gain of 91 pounds of beef per acre also produced a yield of 15.4 bushels of wheat per acre. The wheat yield was severely injured by abnormally wet weather which caused leaf rust. The wheat lodged badly and no doubt this decreased the stand of lespedeza. Throughout 1938 very little difference was shown in total gain per acre between the different methods of grazing. However, when compared to 1937, a dry year, the gain per acre under supplemented grazing was materially increased. In 1937 the gains from bluegrass pasture under supplemented grazing were 110 pounds per acre and 102 pounds per acre from the lespedeza. In other words, an addition of 10 acres of lespedeza to 25 acres of bluegrass (an increase in acreage of 40 percent) increased the total live-weight gains 122 percent over the average gains of the other two pastures.

Thus it is shown that if thought and attention be given to the grazing management of pastures similar to that given to the production of the so-called cash crops, not only will the farm income be increased, but the hazards of short crops and limited feed supplies will be materially reduced. The problem, of course, has many ramifications; at the same time a system of grassland agriculture must be devised which will reduce fertility losses and loss of soil by erosion to a minimum. The ideal pasture improvement program should be designed to increase the supply and quality of forage, thereby lowering costs of livestock production, rather than to increase the number of livestock.

PROFITABLE PASTURES FOR OHIO VALLEY

(*Continued from p. 247*)

Such features as deferred and rotational grazing are dependent on fencing, supplemental pasture, and adequate supplies of good hay. Overgrazing is probably the most outstanding example of mismanagement but can be avoided in most seasons if the other phases of improvement and maintenance are being considered.

A most practical expression of the farmer's response to the program was voiced by a western Kentucky dairyman when he said "I know that I have been guilty of overgrazing and careless treatment but now after 3 years of work I am getting my pastures in good shape. I have learned that lime and phosphate, when applied to the pasture, do not give good results unless I manage them right and mow them often." Whether the pasture is Bermuda grass, bluegrass-white clover, or alfalfa-grass, the time element is an all-important factor in management.

In the final analysis, sensible management is the keystone to successful pasture improvement, but, before approved management practices can be applied on many farms, it is necessary first to establish a vegetative cover worthy of being called pasture.

BETTER PASTURES FOR ILLINOIS

BY E. D. WALKER [1]

A PASTURE can be no better than the soil—such is the message that is being carried to Illinois farmers by the Extension Service as part of the pasture-improvement program in that State. The message is bearing fruit in the form of increased acreage of really good mixed grass-and-legume pasture.

The problem of what to do with land retired from crop production under the adjustment program, the need for grasses and legumes in erosion control, and the failure of old permanent pastures to revive following the drought years of 1934 and 1936 have all served to focus attention on pasture production. For some years Illinois farmers in general have recognized the need for soil treatment to assure them of good yields on much of their cropland. They may not have acted on this knowledge but at least they have recognized the need. But in the matter of pastures no such general acceptance of the necessity of soil treatment prevailed; in fact, the more common notion is that pasturing alone improves the soil. Rolling permanent pastures are expected to go on producing abundantly without treatment of any kind, and cropland worn down to the point of unprofitable returns is merely seeded to grass and called pasture. Much of this pasture land in its present state of fertility produces little and is, in effect, merely an exercise lot for the livestock. It has been the task of extension workers to guide the recent interest in pastures in the right channel and to drive home need for an ample amount of fertility if good forage is to be produced.

Pasture improvement extension in Illinois is no new activity. Rather it should be said that it is receiving new emphasis. Fifteen to twenty years ago farmers were being advised to apply limestone to permanent pastures in order that clovers, particularly sweetclover, might be introduced to produce additional forage and also to improve the growth and quality of the grass by supplying nitrogen to it. Here and there over the State men followed the suggestion, and the pastures they thus established are still among our best available demonstrations.

For example, over 16 years ago the extension agricultural engineer assisted Henry Means of Brown County in terracing a small acreage of worn, gullied cropland which was later limed and seeded to a mixture of bluegrass and sweetclover, and as Mr. Means expresses it, "I shut the gate and I haven't been back except to turn the livestock in or out." The mixture of sweetclover and bluegrass has been maintained throughout the years and with judicious grazing a wonderful sod has developed which precludes any possibility of erosion and which supplies an abundance of good forage. One has only to look over the fence at a neighbor's gullied and well-nigh abandoned field to realize what an excellent job of land use Mr. Means has done. Similar results have been obtained by other men who have followed the same general methods.

Recognizing the increased emphasis being placed on soil conservation by the different departments of the College of Agriculture and by other agencies, a move was made by the Extension Service in 1936 to bring together all the forces working in this direction. The result was a coordinated project in soil improvement and erosion control in which the extension specialists from all the interested departments participated, including agricultural engineering, agricultural economics, crops, forestry, animal husbandry, dairy husbandry, and soils. The Soil Conservation Service has also lent its assistance. By having the specialists cooperate in a project of this type it has been possible to bring to farmers of the State a complete picture of what is needed in a good program of soil improvement and erosion control. This has been a decided improvement over the old method under which each specialist presented separately his angle of the subject, without relating it closely to other phases which should be considered.

The project has been built around the training of a group of leading farmers in each of the cooperating counties. The object has been to train these key men to recognize the problems of soil conservation, to give them information regarding the best methods of improving fertility and preventing erosion, and to inspire them to put these methods into practice on their own farms. The idea has been that after a time these farms can serve as demonstrations on which good conservation practices can be seen in actual operation and, furthermore, that the operators themselves will be sufficiently well informed to pass the information and technique on to their neighbors.

Winter meetings have been held with these leaders during the past three years in an increasingly large

[1] Associate in agronomy extension, University of Illinois, collaborating with the Soil Conservation Service, Urbana, Ill.

number of counties until now almost the entire State is covered. At these meetings the specialists have discussed soil conservation from all angles and have emphasized the place of soil fertility, crops, forestry, engineering practices, and farm planning in the program. Animal husbandry and dairy husbandry also have been brought in from the standpoint of utilizing the crops grown.

Pastures and pasture improvement have entered largely into these discussions. On cropland there is the problem of using the additional acreages of legumes and grasses needed for improvement of fertility and for erosion control. Rotation pasturing presents one good outlet for this forage and has been considered in the building of rotations and in developing farm plans for soil conservation. Soil treatment practices which will ensure regular stands of soil-building legumes are, of course, stressed in this connection.

On the acreage that is to be left in permanent pasture, much of which is rolling land, farmers have been urged to follow practices designed to ensure the heavy growth of vegetation needed to provide a high yield of pasture forage and to control erosion. Combining the experience of practical farmers with experimental data, a suggested program of pasture improvement has been worked out which includes five definite and simple steps:[2]

1. Test and treat the soil: Limestone is needed in varying amounts on most pasture land, and a considerable acreage is deficient in phosphorus.

2. Disk well: This is needed to work lime or phosphate into the soil and make seedbed for new seedings.

3. Reseed: Various mixtures of legumes may be used but sweet-clover is regarded as a stand-by on all types of land. Where few or none of the desirable grasses are present, they should be included.

4. Control grazing: Grazing should be limited sufficiently to maintain a good top growth on the field through the year.

5. Clip weeds: Improving the soil to encourage increased growth of good pasture plants helps with the weed problem, but some clipping is a further aid.

The pasture program has been well received by the leaders who have indicated that there is a wide interest in the subject. Out of more than 3,000 attending the 1939 winter schools, 645 farmers stated that they had carried out pasture improvement work in 1938, and 948 indicated an intention of doing such work the ensuing season. Excellent demonstrations are being developed in this manner. The Tennessee Valley Authority is also cooperating with the College of Agriculture and Extension Service in demonstrational work in the use of phosphates on pastures and legumes. This work is being carried on as part of the coordinated project, and in each of 11 counties in the State from 10 to 20 farmers are developing some excellent demonstrations of the value of lime, phosphate, disking, and legume seedings in increasing the carrying capacity of pastures.

Regardless of how good a demonstration may be developed, it is of value from an educational standpoint only as other farmers visit it, observe the results secured, and learn of the methods used. In view of this fact, tours and field meetings have been a regular and definite part of the activities carried out in connection with the coordinated soil conservation project. Farms used for such meetings have been those on which some good soil-improvement and erosion-control practice has been adopted or on which some good lesson in soil conservation can be pointed out. With respect to pastures, the tours have included some farms where a good improvement program is well under way, some where it has just been started and, for contrast, others where nothing has been done.

Definite evidence is available to show that these tours and field meetings have been effective in convincing farmers of the possibility of improving pastures. For example, William A. Miller, of Schuyler County, attended the pasture tour held by the farm adviser and extension specialist in that county in the summer of 1938, and he was so impressed by what he saw and heard that he immediately started the program of liming, disking, and reseeding on his own permanent pasture field. The resulting stand and growth of pasture grasses and legumes were so good that the field was used for one stop for demonstration on the 1939 tour. Another Brown County man, after visiting the Henry Means pasture mentioned earlier in this article, went home and started the liming of 10 acres of pasture land on his farm. These are only two examples among many that could be cited.

Farmers have been urged to use increased pasture acreage and pasture improvement to control erosion and to take up the slack due to retirement of acreages from crop production under the adjustment program. While it is true that both objectives can be reached by the production of more and better pastures, farmers are reluctant to follow this course because of the idea that pasture land does not hold the same possibility of returns as does cropland. With this in view the effort has been made in all meetings and tours to present information and data indicating income that may reasonably be expected from well-utilized pasture.

Data from the experimental farm at Urbana show an interesting comparison in this connection. Pastures

[2] J. C. Hackleman and E. D. Walker: Five Steps in Pasture Improvement. mm. leaflet, 12 pages, Department of Agronomy, University of Illinois.

used by the animal husbandry department and which have been well limed, phosphated and manured, show a 4-year average production (1934, 1935, 1936, 1938) of 272 pounds of beef per acre. In this test various kinds of pasture have been used including alfalfa, bromegrass, alfalfa-brome mixture, bluegrass, timothy, orchard grass, sweetclover, oats, and other combinations; and this figure represents the average of all these plots during the 4 years. In contrast, beef production calculated on the basis of crop yields secured from rotation land of similar quality and treatment on the south agronomy farm during 4 years, 1935–1938, is somewhat higher than that of the pasture land. When expense of operation is deducted in each case, however, the net return is somewhat in favor of the pasture system. It seems safe to say that good pasture, well utilized, will make a return comparable with that from cropland of equal quality. Results from other experiment stations indicate similar returns.

Farmers over the State who are using pastures to good advantage make similar reports. E. O. Whittaker, one of the T. V. A. cooperators in Bond County, has 70 acres of pasture land which he bought in 1937. He had been renting this land at $1 per acre cash rent, but had decided not to continue this arrangement because it was not profitable. The owner then sold him the land for $12 an acre. The field was limed in the fall of 1937 and sown to rye with a seeding of timothy and redtop. The following spring sweetclover and lespedeza were sown in addition. The entire investment per acre, including cost of land and expense of treatment, was as follows:

Cost of land	$12.00
Lime (4 tons)	10.60
Seeding	2.00
Fencing	5.40
Total	30.00

A herd of dairy cows was run on the field for 2 months in 1938 and for 7 months in 1939. During these 9 months the returns which can properly be credited to the pasture, after making deduction for any other feed fed, totaled $2,610 or $37.29 per acre on a $30 investment. No such return could reasonably have been expected from this land if Mr. Whittaker had depended only on production and sale of crops.

Oscar Linn, a Fulton County farmer, reports that in 1938 a 20-acre permanent pasture field was the most profitable acreage on the farm, its value in feed saved in beef production as compared with dry-lot feeding being over $26 an acre.

Results such as these serve to strengthen the conviction of extension workers in Illinois that they are using sound judgment in recommending that good pastures will control erosion, will make good use of land retired from crop production, and at the same time will offer an opportunity for profitable return. But the fertility needs of the soil must be taken care of, and around these needs the program in Illinois is being built. The plan appeals to farmers, and they are responding because they are beginning to realize that "a pasture can be no better than the soil."

GRAZING PROGRAM IN SOUTHEAST

(*Continued from p. 244*)

a crop of hay for winter feed. The permanent pasture should supply plenty of feed from near the 1st of June until about the 1st of September. By July, the annual lespedeza or the kudzu planted on the hilly land will furnish excellent grazing and can be utilized during any short periods of drought during the summer. Kudzu can be grazed at any time during the fall that is made necessary by the condition of the permanent pasture and the annual lespedeza. A system of this kind will not give year-round grazing, but it would provide a fairly stable supply of feed from early spring, when clovers in the permanent pasture or when winter cover crops in cultivated fields are available, until after frosts in the fall.

It is important that the most suitable land be selected for permanent pastures and that this land be treated with sufficient lime and phosphate to ensure vigorous growth of desirable pasture plants.

The inclusion of other grazing crops in the program will not lessen the need for good management practices such as fertilizing, weed control, and controlled grazing for permanent pastures. The availability of other grazing crops, however, will make proper grazing of permanent pastures feasible. Farmers cannot be expected to remove animals from permanent pastures during periods of drought unless they have some other place available that will provide feed for them.

A further advantage of a grazing program including different types of grazing crops is the reduction in permanent pasture acreage that will be possible. This reduced acreage enables the farmer to give more intensive management and maintenance treatment, including fertilizing, liming and weed control, than is possible on an extensive acreage of pasture.

There are possibilities for winter grazing through the use of small grain, Italian ryegrass, and the winter legumes. The early winter growth of such crops

(*Continued on p. 259*)

FACTORS IN PASTURE MANAGEMENT IN THE NORTHEAST

BY GROVER F. BROWN[1]

IN the Northeast there are approximately 25,000,000 acres of pasture, with about one-third of it classed as woodland pasture. In this vast acreage some 6,030,000 head of cattle, 1,095,000 horses and mules, and 1,486,000 sheep are grazed. Good pastures produce the most economical feed for these classes of livestock, and for this reason pasture management is of utmost importance to farmers of the region.

The length of the grazing season varies from 5 to 7 months. Many farmers allow their livestock to roam the pastures during most of the year—a practice that is extremely injurious to the better pasture plants. Winter feeding of corn fodder and hay, on the pastures, is common in some sections also, and this in itself is likely to be a source of damage to the vegetation. Such winter feeding seriously damages soil structure through trampling so that moisture penetration is hindered and rapid run-off of practically all rain and melting snow occurs. It may result also in complete denudation of the above-ground vegetative parts which if protected are valuable as winter cover.

From the point of view of pasture management there are at least three periods in the grazing season when care must be exercised to prevent undue damage to desirable pasture plants. One of the major causes of decreasing vigor of pasture plants is too early grazing in the spring before the ground is sufficiently dry to prevent damage by trampling and before the vegetative parts of the plants have had an opportunity to replenish food reserves in the roots. Some plants, such as wild white clover, suffer from shading when the grass in the pasture mixture grows too tall. However, when the faster-growing grasses are grazed too closely in the early spring and are not given an opportunity to recover while growing conditions are favorable, their production suffers later in the summer when conditions are often unfavorable.

Supplemental pastures usually are necessary for the average Northeastern farmer during the hottest part of the summer. At this season of the year severe overgrazing of the better pasture plants may damage them so severely that they cannot compete with the annual weeds that spring up in the early fall. Proper rotational grazing sometimes helps in carrying the livestock over this season. In dry years, however, even the best permanent pastures cannot carry the same load in midsummer that is advisable in the spring and early summer for the utilization of the herbage then available.

With the coming of cooler weather in late summer and early fall and its accompanying lower evaporation and transpiration, the permanent pasture grasses and legumes have opportunity to regain their vigor rapidly and prepare themselves for winter. If they are too closely grazed before and during this season, they must of necessity go into the winter in an undernourished condition, and this leads to severe winter injury. Late fall and winter pasturing can thus be an extremely harmful practice for farmers with grazing livestock.

For many years the agricultural experiment stations have pointed out the value of proper liming and fertilizer treatments of pastures. Likewise, the value of mowing to control weeds and prevent pasture herbage from maturing has been proved many times. It is apparent, however, in many areas, that these proved and tested practices require further stressing to maintain progress in an advantageous grazing management and pasture program. In recent years a great deal of attention has been given to the production of superior types of pasture plants, and this in itself undoubtedly will be of immense value to pastures of the Northeastern Region.

Proper liming, fertilizing, seeding, mowing, and grazing management all are extremely important, but unless there is sufficient moisture in the soil there can be no plant growth. For this reason, moisture may well be listed as one of the fundamental pasture requirements. In the irrigated sections of the West this factor has been given primary attention, but in the humid sections of the East farmers have depended so completely upon rains coming at the right time that very little effort has been expended in the supplementing of natural rainfall. Practically the entire system of "dry-land" farming and "summer fallowing" west of the Mississippi is based on the storing of water in the soil before it is required for plant growth so that it will be available when needed. Since this practice is desirable and feasible, does it not follow that surplus moisture in seasons of plenty should be stored in the

[1] Regional agronomist, Northeastern Region, Soil Conservation Service, Upper Darby, Pa.

soil for use by pasture plants during the periods of scarcity in summer wherever it can be done economically?

Contour pasture furrowing is one of the practices which the Soil Conservation Service has sponsored to help this condition of moisture shortage during summer months. If the grazing season can be extended at this season of the year by only a few days, it will in many cases justify the small costs involved. Many of our summer rains come in the form of heavy thunder showers of high velocity and short durations. As a result of the more or less dormant condition of the vegetation and the dry hard condition of the surface soil, much of the water from these rains is lost to the pasture by run-off. This fact is particularly important on steeper portions of the pasture where the surface soil is thinner and the stand of vegetation sparser. It has been shown by soil conservation experiment stations that on good pasture sod, with limited slope and length of watershed, practically no run-off occurs. Yet under general pasture conditions, especially on overgrazed and poorly managed pastures, there undoubtedly is run-off, which means water wastage, lost fertility, and soil erosion.

As properly constructed in the Northeastern Region, contour pasture furrows have a holding capacity of approximately one acre-inch, equivalent to about 113 tons of water per acre. Many of our summer thunder showers are of this quantity or in excess. Increased absorption by reason of the furrows, plus normal soil absorption, should do much toward extending the summer grazing season.

Preventing surface run-off from at least the steeper, poorer spots in the pasture aids in preventing run-off from the pasture as a whole. This in itself is important to the farmer and others as well in that it reduces possible flood hazards on the lower reaches of the watershed, reduces siltation of reservoirs, erosion of bottomlands below the pastures, and other damages attributed to excess run-off.

When rainfall during the growing season is below the amount of moisture lost by evaporation plus that lost by transpiration, either artificial application of water is necessary or the plants must obtain additional water from the subsoil to enable them to continue to produce satisfactory pasturage. Practices which aid in maintaining optimum subsoil reserves should be stressed by any agency interested in the farmer's pasture problem.

Upon close examination of furrowed pastures in the Northeast, it has been noticed that more clover and desirable grasses grew in the furrow than between furrows. This fact may be attributed to more moisture, lower temperature, less evaporation and transpiration in summer, and also to the lodging of small seeds that are carried down the slope by any movement of water between furrows. Run-off water carries soluble fertility, and this may account for increased growth of vegetation on furrowed pastures.

Rear view of contour furrowing machine, showing construction and pattern of roller.

As the cost of furrowing a pasture is largely one of labor, furrowing may be done during the fall or early winter when surplus labor is available. If a pasture is planned for treatment with lime, fertilizer, and seed, furrowing should be done in advance so that revegetation of the disturbed areas can be accomplished more rapidly. On pastures of low-carrying capacity because of insufficient desirable plant population, furrows may be constructed with the ordinary farm plows. Such furrows seem best when placed about 10 feet apart on the ground surface, with each furrow made by one or two rounds of the plow. Because of the fact that the lateral movement of water through the soil is very limited, the furrows must be fairly close together for maximum benefit to the vegetation.

The machine shown in the accompanying photograph has been patterned after one in Region 5 and is used for furrowing pastures already having a fairly good covering of vegetation. This machine does not turn over the existing sod as does a plow or terracer blade, and for this reason the immediate reduction in carrying capacity is greatly lessened. It also means less exposed ground surface to revegetate.

Approximately 6,000 acres of permanent pastures have been furrowed in the Northeastern Region during the past few years, and many additional acres are being planned. Those farmers who have suffered the experience of summer drought on their pastures, with its consequent costly barn feeding, are quick to appreciate the value of conserving rainfall and putting it to maximum beneficial use.

RUN-OFF UNDER DIFFERENT SYSTEMS OF GRASSLAND MANAGEMENT

BY H. C. KNOBLAUCH AND J. L. HAYNES [1]

IT is generally recognized that land used for grass production under most systems of management does not present as serious an erosion problem as does land devoted to cultivated crops. Difference in run-off, however, from various types of grass under different systems of management are less widely appreciated. Good pasture sod actually may give more run-off than clean-tilled crops under certain types of management. Management of grassland as pasture usually results in greater surface run-off than equally good stands of grass managed as hay. During winter months grassland frequently has more run-off than cultivated land, because of differences in frost content in the soil.

Inasmuch as moisture demands for optimum growth are much higher under grassland than under most cultivated crops and as the moisture requirements for grass are sustained throughout the growing season, it is important from the standpoint of yield that proper consideration be given to the relative effectiveness of methods of grassland management in prevention of run-off.

To determine soil and water losses under various agricultural practices related to dairy farming in the Northeast, the Beemerville Soil Conservation Experiment Station was established near Sussex, N. J. Considering the predominant type of agriculture of the area, investigations at the station were directed toward problems connected with grassland farming. Experiments were undertaken to determine soil and water losses from pasture land when rotational grazed and when under continuous grazing, from areas planted to grass-legume mixtures cut for ensilage, and from corn plots harvested for ensilage. Supplementary to the run-off studies, data on crop yields were obtained from the different systems of pasture management and from the various seeding mixtures used both for pasture and ensilage purposes. Some of these studies have been under way since 1937 and preliminary results are reported in this article.

The area represented by the station normally supports a very good pasture cover. The composition of pastures generally accepted as desirable for the area and that frequently obtained in properly managed pastures consists of 35 percent Kentucky bluegrass, 35 percent wild white clover, and the remaining 30 percent of various grasses and legumes, principally timothy and redtop. The mixture seeded on the plots used in the pasture management study consisted of Kentucky bluegrass, timothy, wild white clover, red clover, and alsike clover.

The soil at the station is Dutchess loam. It has developed from the underlying shale and from glacial material. In the cultivated condition, it has a brown to grayish-brown friable surface soil 0 to 8 inches in depth. The B horizon is light brown in color and somewhat more compact than the surface soil. The degree of compaction tends to increase in the subsoil. Evidence of imperfect drainage is frequently observed at depths of 24 to 30 inches. The soil is relatively high in fertility; however, most areas show marked response to fertilizer treatment. Because of the necessity for a uniform soil, slope, and erosion condition, the particular area selected for pasture management studies was in a high state of fertility due to previous treatment.

Pasture management studies are conducted on six 0.7-acre fields. Three of these are rotationally grazed and fertilized, while three are continuously grazed without fertilizer treatment. For run-off studies, each of the 0.7-acre grazing areas has located in it a 14- by 70-foot plot equipped with run-off measuring equipment. The management of the run-off plot area is the same as on the surrounding field area. With this arrangement, it is possible to get records of pasture days and animal gains as well as soil and water losses.

Vegetation on the rotational plots of this study is allowed to reach a height of 4 to 6 inches before grazing. A sufficient load is then turned on to graze the plots to approximately 1 inch within 10 to 14 days, at which time cattle are removed until recovery to 4 inches is made. Cattle are turned on the continuously grazed plots early in the spring and removed late in the fall. The grass on the continuously grazed plots usually is kept at a height of 1 to 1½ inches except during periods of insufficient moisture when the sod may be grazed to one-half inch. Both the rotational and continuously grazed plots are mowed at least twice during the season to prevent spotty grazing.

[1] The authors are project supervisor, Soil Conservation Service Research, New Brunswick, N. J., and junior soil conservationist, Beemerville Soil Conservation Experiment Station, Sussex, N. J., respectively. The article reports experiments carried out by the Office of Research of the Soil Conservation Service, cooperating with the New Jersey Agricultural Experiment Station.

Under continuous grazing, the sod mat forms close to the ground, white clover assuming a prostrate growth habit and filling the interstitial spaces left by the grasses. Normally a nearly complete ground cover is maintained even under severe grazing, as the plants spread so close to the ground that cattle do not strip the soil of its cover. Under the rotational system as used in this study, the closed canopy forms higher from the ground, the clover becoming more erect in competing with the growing grasses for sunlight. Thus, upon completion of a grazing period on the rotational plots, as much as 40 percent of the soil surface may be exposed with no vegetative cover while the continuously grazed plots ordinarily will have 90- to 100-percent ground cover through the season.

Comparing run-off from rotational and continuous grazing, as these practices are being carried out at this station, it will be noted in the table that run-off under continuous grazing was higher than from the plots under rotational grazing. This trend persisted throughout all seasons. Records from individual storms occurring at the close of grazing periods on the rotational plots, when percentage of ground cover was in favor of the continuously grazed plots, consistently showed more run-off from the continuously grazed pastures. It is thus apparent that vegetative cover is not the sole factor influencing run-off from pasture land. Observations and evidence from associated studies indicate that the influence of continued trampling on soil structure by cattle is one of the factors contributing to difference in run-off. It should be kept in mind, however, that the continuously grazed plots were grazed closer than the rotational plots.

The use of grasses and legumes for ensilage is rapidly becoming an important part of farm management in this as well as in some other areas where the major portion of the farm income is derived from dairying. Measurements of soil and water losses are made at the station from plots planted to a grass-legume mixture of alfalfa, timothy, alsike, and red clover, being managed for silage. These plots are normally harvested twice annually, when the alfalfa starts to blossom.

As a means for comparison of soil and water losses and of crop yield, corn silage plots drilled with the slope were installed adjacent to the grass-legume silage plots. All the silage plots are on a 16-percent slope and are on a soil closely comparable with that of the pasture management plots described above.

Referring to the table it is observed that management of grassland for silage or for hay prevents run-off more effectively than does utilization for pasture, and

Table showing run-off from grassland under different systems of management as compared with that from corn planted with the slope

Season	Rainfall	Run-off from corn (silage)	Run-off from grass-legume (silage)	Run-off from bluegrass-clover sod, continuous grazing	Run-off from bluegrass-clover sod, rotational grazing
	Inches	*Percent*	*Percent*	*Percent*	*Percent*
June, July, Aug.	14.59	8.2	3.4	8.8	5.7
Sept., Oct., Nov.	11.64	7.3	2.2	8.2	4.8
Dec., Jan., Feb.	11.54	40.6	9.1	44.2	25.4
Mar., Apr., May	11.31	1.0	0.2	1.0	0.3
Total, 12 months	49.08	14.0	3.7	15.2	8.9
Annual soil loss (tons per acre)	....	10.88	0.05	0.22	0.17

that this trend is sustained throughout the season. The grass-legume silage plots are not subjected to compaction by animals as are the pasture plots, and the soil is thus more porous.

In comparing run-off from grassland with open tillage, as represented by corn in the table, it will be noted that during the period of study from which these records were collected, water loss from continuously grazed pasture land somewhat exceeded that of corn throughout the year. Inspection of individual storm records, however, shows that run-off starts from corn or corn-fallow plots before it does from grassland. This may be due in part to resistance caused by physical obstruction to overland flow by the vegetation. But with sustained rainfall, causing run-off, the initial effect of run-off detention by grass cover frequently is overshadowed by the effect of higher permeability of corn ground in this experiment, causing the gross totals to reflect a slightly higher run-off under continuously grazed pasture. Under rotational grazing, permeability of the soil apparently has not been reduced to an extent to cause run-off equal to that from soil being used to grow corn for silage. Since the structure of soil under grass-legume silage plots is undisturbed and more porous, the high permeability, the high initial retention by canopy interception, and resistance to overland flow by vegetation are reflected in a very low percentage of run-off.

As indicated earlier, different mixtures were placed under study to obtain information on their relative values for soil conservation purposes and for the production of ensilage and as pasture. Ladino clover was included in one of the mixtures. The Ladino clover mixture included red clover, alsike, timothy, and alfalfa. Seeding was in the spring of 1937 and one cutting was made during the first year. In 1937 the plant population was very similar to the percentages of the mixture planted. Grazing and harvesting for

silage were started in 1938. Under grazing and silage management, Ladino suppressed all other species of the mixture to a small proportion of the total composition by the end of the 1938 grazing season. The area harvested as silage yielded 28.6 tons green and 3.98 tons dry weight per acre for three cuttings in 1938. The high yield and success of Ladino in crowding out all other species probably was due, in large part, to the very wet season in 1938. Ladino plots under rotational-grazing management gave 408 grazing days per acre for a 1,000-pound animal during 1938. During the very dry year of 1939, Ladino harvested for silage was about equal to the standard grass-legume mixture

From the conservation standpoint, the rapidity of growth recovery of Ladino is effective in providing a complete ground cover, and the stoloniferous character of the plant provides a good surface mat of roots when managed as silage. Under pasture conditions, however, the stolons appear to be easily uprooted by animals, especially under close grazing, and the animals are able to take almost all the leaves from the plants, so that only very little cover is left on the soil, such as is maintained by white clover.

Summer rainfall, during the period covered by this report, showed extreme variability. The 36-year average precipitation for the Sussex area for the season, May to September inclusive, is 20.25 inches. During 1938, 36.69 inches were recorded during the above period, while in 1939 only 12.09 inches were received.

During the wet season of 1938, rotational grazing showed slightly higher yield than continuously grazed pasture. However, due to the custom of waiting for a growth of 4 to 6 inches before grazing on rotational pastures, this practice was less productive than was continuous grazing during the drought year of 1939 when growth recovery was slow and when very little run-off occurred during the grazing season; in this year of drought there was little difference in amount of moisture conserved in the two practices.

Under conditions represented by the Beemerville station, soil losses under any reasonably good system of grassland management are small, except from new seedings. Differences are apparent, however, between various systems of grassland management, as shown in the table. The comparatively recent movement in agricultural practices, from corn silage toward grass-legume silage, is to be welcomed by the conservationist as a big step in the solution of one of the major soil conservation problems in dairy farming.

PASTURE IN RELATION TO CROPLAND

(*Continued from p. 242*)

the range country of the West, a system of extensive farming must be followed, except on irrigated land. In the more humid sections of the Great Plains and the western part of the Corn Belt the proportion of pasture to cultivated cropland can be regulated to meet the necessary balance which must be maintained between crops and livestock. It can be adjusted also to meet variations in soil, slope, and, to a more limited extent, the general fertility problems of the individual farm.

The pendulum swings. First from too much grass to too much cropland; now it is swinging back to grass—grass that will permit a diversified agriculture, prevent our fertile soil from becoming a burden in the winds or the major drainage channels of the country, and provide a stability of agriculture not yet attained in our country.

A new pasture seeding of bromegrass and alfalfa. The present farmer is trying to solve the problem of restoring a balance between his crop and grass lands. Grass in strips is used to prevent erosion on cropland, and grass is also in favor for hay and pasture.

Beef cows and calves on an alfalfa-grass pasture in central Illinois. Such livestock makes the maximum use of hay, pasturage, and other roughage. While adequate crop rotations are fundamental to the maintenance of crop yields, shifting acreage from corn and other tilled crops to hay and pasturage does not increase the production of meat, milk, and other livestock products.

MORE AND BETTER FORAGE PAYS

TO MEET the land-use capabilities on most farms where erosion is a serious factor requires a considerable decrease in the acreage of the common cash crops and an increase in the acreage of hay and pasture. To bring such changes about and make them relatively permanent, the decrease in income from cash crops must be offset by an increased income from the hay and pasture. This generally involves greater emphasis on getting profitable returns from the livestock that are being kept or should be kept on the farm to balance the cash crops, and depends to a very large extent upon the fact that feed from pasture is much cheaper than feed from harvested crops.

In an economic study of dairy farming, Marvin Guin of the Mississippi Agricultural Experiment Station, points out the importance of properly cured hay and other roughage in making dairy cows pay. He says that from 75 to 85 percent of the roughage in Oktibbeha and Lowndes Counties is poor in quality because mowing is delayed until the hay is overripe. This condition, together with overexposure in curing, causes the hay to lose most of its leaves—by far the most nutritious and palatable part.

Helpful information on the making of hay of better quality and higher feeding value is contained in a number of United States Department of Agriculture bulletins and circulars such as the following:

Farmers' Bulletin No. 1525: Effective Haying Equipment and Practices for Northern Great Plains and Inter-Mountain Regions.

Farmers' Bulletin No. 1539: High-Grade Alfalfa Hay: Methods of Producing, Baling, and Loading for Market.

Farmers' Bulletin No. 1597: The Production of Johnson Grass for Hay and Pasturage.

Farmers' Bulletin No. 1770: High-Grade Timothy and Clover Hay: Methods of Producing, Baling, and Loading for Market.

Circular No. 534: Lespedeza Sericea and Other Perennial Lespedezas for Forage and Soil Conservation.

Circular No. 536: The Annual Lespedezas as Forage and Soil-Conserving Crops. —A. T. S.

GRAZING PROGRAM IN SOUTHEAST

(*Continued from p. 253*)

usually is limited because of periods of drought which frequently extend from late August to the latter part of November. Naturally, when such unfavorable seasons occur, it is impossible to get winter crops started in time to provide grazing before late winter. It is necessary, therefore, for farmers to harvest a sufficient amount of hay and other feed to carry their cattle through the winter. The winter feed can be supplemented to some extent by grazing in the fields during the early part of the winter. This is particularly true where there is a considerable acreage of kudzu on the farm. The frosted leaves of kudzu are grazed by livestock until midwinter.

Last but not least in a grazing program is the proper adjustment of livestock population to the size of the farm. In too many instances the number of livestock kept on the farm is determined by the desire of the farmer for livestock income, rather than by the capacity of his farm for supporting livestock. Overstocking will make it impossible for any grazing program to be operated successfully.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE AGRARIAN REVIVAL. By Russell Lord. American Association for Adult Education. New York, 1939.

Again Russell Lord has produced a book about an important phase of recent agricultural development in this country. Specifically, it is an intimate account, packed with stories of the people, of farm and farm home extension teaching from its origin to the present. It is indeed a most democratic book in more ways than one; it shows how initiative from the people starts an important idea going, how great institutions grow, slowly and with much healthy "rowing" as they are worked out by the people for the good of the people, and how at the proper time Government serves its useful purpose. Enriched by historical notes and intimate episode and vivid characterization, it is not just a book to remember as "something I read once"; it is a book that will help us all to understand a lot of things about patience in the working out of democractic institutions.

The approach is by way of rapid sketch of individual and local effort: Indian demonstration unheeded if interfering with exploitation; then unplanned or badly planned agricultural expansion with rectangular farms and 7-mile furrows; then the land-grant colleges, brought into being in time of civil war; and then many a tale of the patriarchs of agricultural education blazing the way for extension teaching, wanted by the people on the land, "at the grass roots." Davenport, Bailey of Cornell, Knapp and Spillman, Roberts, Perry Holden the "Corn Man," A. J. Whimple the farmer, "Uncle Henry" Wallace and "Tama Jim," Wilson—these are men who had much to do with the trail blazing, and they are given considerable space as agricultural teachers or workers who "weather well" or whose works are even today definitely responsible for the dissemination of knowledge by the extension method.

The story of the county-agent system of extension teaching, as it has developed from State and farmer organizations throughout the past four decades, has somewhat the tone of early pioneer history. There is the same healthy and vigorous "free talk," the same regional differences, and men and women working from dawn to far into the dark to carry adult education to the farm and the farm home. Mr. Lord worked in Ohio as an extension newsman, and he has happily chosen that State as "as representative a State as any, and perhaps the most widely representative, in a median sense" in a study of the growth of ideas and methods in extension during the post-war era. Aside from the fact that Ohio is a representative State as regards extension teaching, here is the interesting and inspiring sketch of John D. Hervey, county agent in the hills of southwestern Ohio, as well as a fine and illuminating character study of the agricultural population of Ohio.

The latter half of the book carries extension education through the vicissitudes of depressed economic conditions when farmers and farm educators raised standards and wrestled with change and turmoil. In this period home economics especially forged ahead, while Triple-A adjustment was piled high upon the shoulders of extension men in the field. In his study of agricultural adjustment payments, Russell Lord gives us an excellent account, from the ground, of the Triple-A. It is the comments from far afield that are revealing and help us to understand so many things about balance of farm production. Here, too, are more character sketches and episodes to enrich the story. We are very near "home," to present-day trends, in the last few chapters of the volume where our own Secretary of Agriculture, and M. L. Wilson, both well known to us, are sketched most revealingly as to work, ideals and character. [Most significant, by the way, is the latter's recent appointment as Director of the Extension Service of the Department of Agriculture. He was Montana's first county agent.] And here Mr. Lord, who states facts boldly, points out that one important result of depression and emergency tactics is the acceleration of soil conservation and land use for a balanced agriculture. He tells us, furthermore, that the "real story is not in Washington . . . [but] is developing in terms of an increasing participation by farm men and women in changed ways and methods, and in planning and action groups forming at the grass roots, out on the ground." This brings to mind the soil conservation district.

The final chapter is called the "Conclusion" and here is a summing up of farm needs and State and governmental relationships. The real summation is twelve lines from the bottom of the last page in these words: "Whether the device is a new plant or animal, a changed tillage or household method, or a new social mechanism, it has to stand up in the field or be modified in action while it works."

PREVENTION AND CONTROL OF GULLIES. By Hans G. Jepson. U. S. Department of Agriculture Farmers' Bulletin No. 1813. Washington, D. C. September 1939.

"Any gully, no matter how large, and regardless of its condition, will usually be reclothed with vegetation, provided it is properly protected and is in a locality where vegetation will grow." This sentence, and this one, "To prevent the formation of a gully is much better and easier than to control it once it has formed" are chosen from Mr. Jepson's new bulletin as those most suggestive of the practicality and completeness with which the subject is treated. Designed for farmers, the work should prove indispensable to farmers—and to agricultural engineers planning or helping to plan gully prevention or control.

Mr. Jepson is assistant agricultural engineer in the engineering division of the Service, and this bulletin was meticulously prepared in cooperation with other divisions of the Service. The 60 pages are devoted entirely to practical and approved methods for planning complete gully control including proper treatment of the drainage area as well as of the gully itself.

For estimating run-off from a drainage area, a table showing probable run-off from watersheds of various characteristics and acreage is given, along with directions for use. Following this is a discussion of methods for retaining needed run-off, and control of excess run-off by diversion of water from the gully head or by conveying it through a properly protected gully or gully system.

The protection and control of gullies by means of heavy vegetative growth is of course emphasized, with directions for planting and seeding. Special proved woody plants (trees, shrubs, and vines) and grasses and legumes are named and described as to use and methods of planting in gullies. Sod flumes, sod checks, and sodded earth fills are treated in detail with special attention to the transplanting of sod.

The latter half of the bulletin is devoted to structures to be used in gullies to aid in establishing vegetation, or where necessary for permanent protection. Some of these structures can be built by the farmer himself at practically no cost; detailed directions are given and illustrated by drawings and photographs, and types of structures are designated as to material available and size and characteristics of the gully. Temporary check dams to be constructed of wire, brush, loose rock or rough timber, are pointed out for use in gullies that have small drainage areas. Tables are shown for determining probable run-off and the size of rectangular spillway notch required to handle it.

Permanent soil-saving dams are recommended as frequently necessary where gullies must be retained as permanent waterways, to check advancement of large gullies, for water impounding, culverts, etc. Some excellent diagrams show different views of a small rubble masonry dam, a small concrete dam, and the drop-inlet soil-saving dam with square culvert. A table shows drop-inlet culvert sizes required for discharges of 25 to 550 cubic feet per second.

The masonry head flume and the concrete head flume are described and illustrated for use where it is necessary to convey run-off down steep banks or overfalls to a base grade. Jetties for control of erosion of small stream banks are described briefly but in detail; and, finally, some helpful suggestions are given for repair and maintenance of erosion-control structures once they are established to function properly.

U. S. GOVERNMENT PRINTING OFFICE: 1940

Latest List of State and National Publications Takes In Wide Range

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information U. S. Department of Agriculture

Crops Against the Wind on the Southern Great Plains. Farmers' Bulletin No. 1833. Soil Conservation Service. December 1939.

Effect of Accelerated Erosion on Silting in Morena Reservoir, San Diego County, Calif. Technical Bulletin No. 639. Soil Conservation Service and California Forest and Range Experiment Station, Forest Service. December 1939.

Erosion and Related Land-Use Conditions on the Spartanburg Municipal Reservoir Watershed, S. C. Soil Conservation Service. January 1940.

Erosion and Related Land-Use Conditions on the University Lake Watershed, Chapel Hill, N. C. Soil Conservation Service. December 1939.

Hart Mountain Antelope Refuge: A National Wildlife Refuge in Oregon. Miscellaneous Publication No. 355. Bureau of Biological Survey. June 1939.

Kudzu for Erosion Control in the Southeast. Farmers' Bulletin No. 1840. Soil Conservation Service. December 1939.

Rainfall Characteristics as Related to Soil Erosion. Technical Bulletin No. 698. Soil Conservation Service. December 1939.

Agricultural Experiment Stations

Agricultural Seed. Bulletin No. 454. Agricultural Experiment Station, Burlington, Vt. November 1939.

Care of Citrus Groves Injured by Cold. Press Bulletin 546. Agricultural Experiment Station, Gainesville, Fla. February 1940.

Chemical Composition of the Soils of Cass, Dickens, Falls, Hardeman, Polk, Scurry, and Wheeler Counties. Bulletin No. 581. Agricultural Experiment Station, College Station, Tex. January 1940.

Corporate Land, Foreclosures, Mortgage Debt, and Land Values in Iowa, 1939. Research Bulletin 266. Agricultural Experiment Station, Ames, Iowa. December 1939.

Defects Which Reduce Quality and Yield of Oak-Hickory Stands in Southeastern Iowa. Research Bulletin No. 269. Agricultural Experiment Station, Ames, Iowa. December 1939.

Drainage on the Farm. Circular No. 304. Agricultural Experiment Station, Berkeley, Calif. Revised June 1939.

Drainage and Irrigation, Soil, Economic, and Social Conditions, Delta Area, Utah. Division 4, Social Conditions. Bulletin No. 288. Agricultural Experiment Station, Logan, Utah. June 1939.

An Economic Study of Land Utilization in Yates County, New York. Bulletin No. 727. Cornell Agricultural Experiment Station, Ithaca, N. Y. January 1940.

Eleven Years of Soybean Investigations: Varieties, Seeding, and Storage. Bulletin No. 462. Agricultural Experiment Station, Urbana, Ill. January 1940.

Factors in the Organization and Operation of Farms in an Upland Cotton Area of Louisiana. La. Bulletin No. 309 (also La. Bulletin No. 309-A—abstract of La. Bulletin No. 309). Agricultural Experiment Station, University, La. October 1939.

Factors Influencing the Availability of Native Soil Phosphate and Phosphate Fertilizers in Arizona Soils. Technical Bulletin No. 82. Agricultural Experiment Station, Tucson, Ariz. September 1939.

Farm Research in South Dakota. (Fifty-Second Annual Station Report, July 1, 1938–June 30, 1939.) Agricultural Experiment Station, Brookings, S. Dak.

The Farm Woodlot: A Source of Permanent Income if Handled Wisely. Bulletin No. 367. Montana State University, Missoula, Mont. June 1939.

Fifty-Second Annual Report, 1938–39, Colorado Experiment Station. Colorado State College, Fort Collins, Colo. July 1939.

Highlights of the Work of the Mississippi Experiment Station. (Fifty-Second Annual Report for the Fiscal Year Ending June 30, 1939.) Mississippi State College, State College, Miss.

Lupine, A Seed-Producing Winter Legume. Press Bulletin 541. Agricultural Experiment Station, Gainesville, Fla. November 1939.

A Physiological Study of the Winter Wheat Plant at Different Stages of Its Development. Technical Bulletin No. 47. Agricultural Experiment Station, Manhattan, Kans. July 1939.

Prices and Pennsylvania Agriculture. Bulletin No. 384. Agricultural Experiment Station, State College, Pa. October 1939.

Rainfall and Discharge Records for Northern Iowa Drainage Districts. Bulletin No. 141. Engineering Experiment Station, Ames, Iowa. May 1939.

Soil Management Experiments. Bulletin No. 397. Agricultural Experiment Station, Lexington, Ky. November 1939.

Soybeans in Nebraska. Bulletin No. 322. Agricultural Experiment Station, Lincoln, Nebr. October 1939.

Taro Varieties in Hawaii. Bulletin No. 84. Hawaii Agricultural Experiment Station, Honolulu, T. H. December 1939.

The Use of Chemical Methods for the Determination of Available Nutrients in Louisiana Soils. La. Bulletin No. 313. Agricultural Experiment Station, University, La. December 1939.

Yield and Composition of Everglades Grass Crops in Relation to Fertilizer Treatment. Bulletin No. 338. Agricultural Experiment Station, Gainesville, Fla. October 1939.

Miscellaneous

Conserving Soil Through the Farm Program. (Questions and Answers) For use in the States of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, and Texas. SRAC-No. 6. Southern Division, Agricultural Adjustment Administration, U. S. Department of Agriculture. December 1939.

Farm Horizons. Cornell Extension Bulletin No. 423. (Prepared by Seneca County Agricultural Conference Committee, Ovid, New York.) Cornell Agricultural Experiment Station, Ithaca, N. Y. November 1939.

Field Mechanics of Terracing. Publication No. 227. Agricultural Extension Service, Knoxville, Tenn. August 1939.

Four Years of Farm Accounts in the Coon Creek Soil Conservation Demonstration Area. Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture in cooperation with Wisconsin Agricultural Experiment Station. October 1939. mm.

A Preliminary Economic Appraisal of the Soil Conservation Program in the Little Antietam Creek Watershed, Franklin Co., Pa. Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture in cooperation with Pennsylvania Agricultural Experiment Station. December 1939. mm.

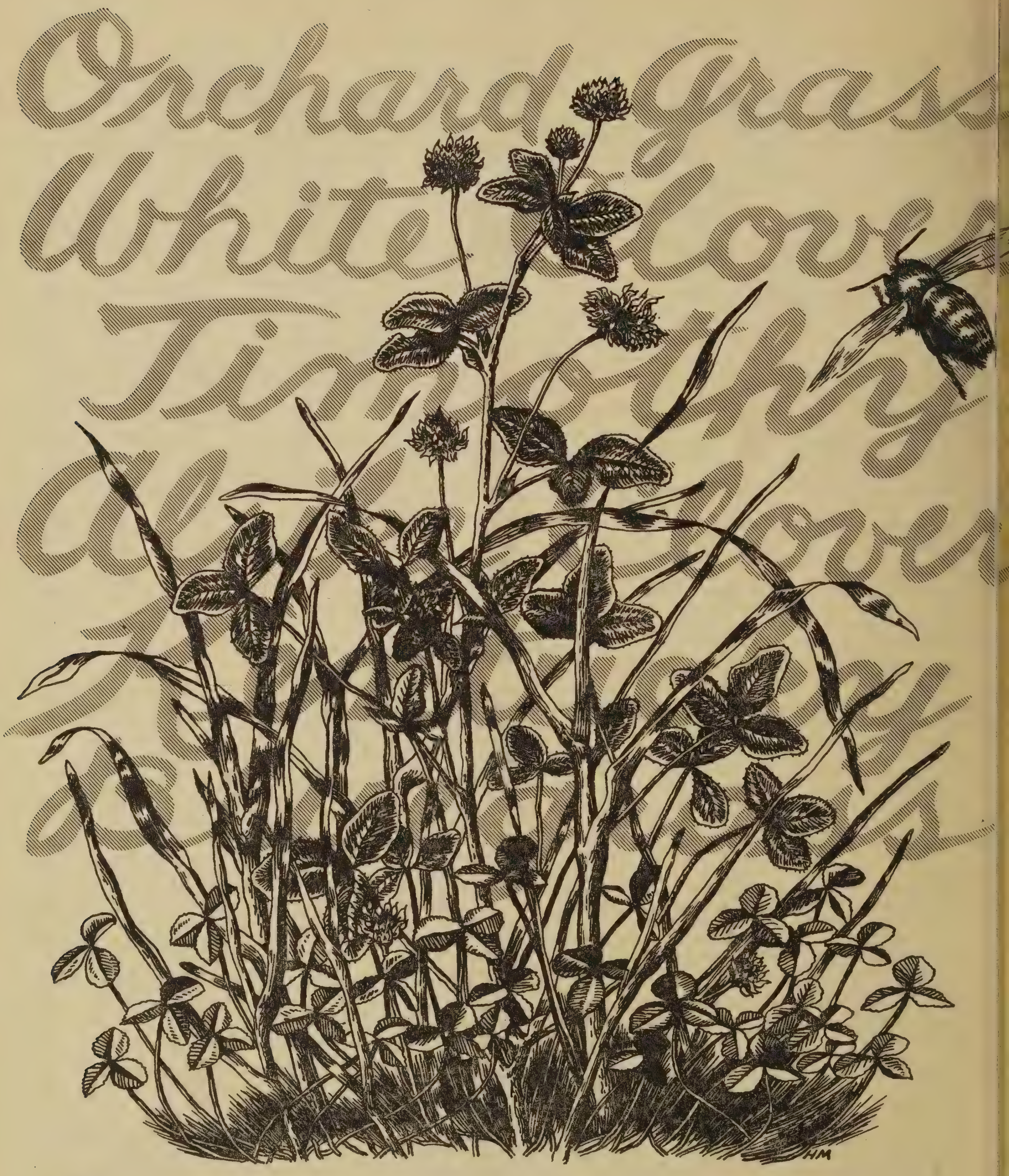
Progress Report, 1939: Statement of the Advisory Committee. National Resources Committee, Washington, D. C. June 1939.

A Study of Farming in the Prairie Creek Soil Conservation Demonstration Area, Rice County, Minn. (Some Implications of the Recommended Soil and Water Conservation Program. A Preliminary Report.) Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture, in cooperation with Minnesota Agricultural Experiment Station. December 1939. mm.

Terrace Outlet Waterways. Publication No. 228. Agricultural Extension Service, Knoxville, Tenn. September 1939.

Units in Conservation for West Virginia Public Schools. Volume I—Elementary Schools, Grades 1 to 8. Volume II—Secondary Schools, Grades 7 to 12. Conservation Commission of West Virginia in cooperation with State Department of Education. April 1939.

Using Farm Timber Crops for Better Income. Circular No. 171. Clemson Agricultural College, Clemson, S. C. April 1939.



A mixture of common grasses and legumes found in northeastern and Corn Belt pastures.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

MAY
1940

Contents

Front cover by Adrian Clem
Back cover by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 11 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON MAY • 1940

Choice pasture land to the east of Minden and within Nevada soil conservation district No. 7.

CONSERVING KEY AREAS IN SOUTHWESTERN RANGE LANDS

By C. C. SIKES [1]

CONSERVATION values are often difficult to segregate; many times they are so distributed throughout the land-use pattern that at first glance the efforts of conservationists may seem misplaced or out of proportion to the good that is done. This probably is nowhere else as true as in the conservation programs of the West, and particularly in Nevada. Nevada contains over 70 million acres of land, of which 8 million are privately owned, with half of all the privately owned lands included within grants to railroads. Of the land in private ownership, less than 700,000 acres are irrigated, and it has been reported that these irrigated acres, amounting to less than 1 percent of the State's total, provide feed to livestock 50 percent of the time. These fertile irrigated acres are scattered in varying sized groups throughout the State.

These small areas usually consist of valleys where pasture, meadow hay, or irrigated alfalfa is raised to carry the livestock through the winter period when

[1] Assistant regional agronomist, Pacific Southwest Region, Soil Conservation Service, Berkeley, Calif.

222612—40——1

most of the better range is covered with snow—the word "Nevada" is from the Spanish and means "snow-covered." The "oases," as they are termed, are actually the key spots in this vast grazing State, because the total production of livestock is governed to a large degree by their capacity, with their alfalfa fields, hay, and native grass pastures, to produce the necessary supplemental feed for winter use. They are, therefore, of great importance to the livestock industry.

For the protection of these small fertile areas a conservation program is being worked out jointly by the Soil Conservation Service, the Indian Service, and the Extension Service, on a somewhat typical area of 289,500 acres, comprising the Duck Valley Indian Reservation, half of which is in Idaho and half in Nevada. Owyhee, the principal community, including most of the 140 families on the reservation, lies in the reservation's valley, which is approximately 6 miles wide and 20 miles long. Within the boundary of this valley are the irrigated lands. The surrounding bench lands furnish typical desert-range grazing and are covered with sagebrush, annual and perennial grasses. At the higher elevations there are dense stands of perennial grasses which provide excellent summer feed.

In the past it has been customary for the Indians to lease the grazing rights on their land to outside stockmen, and the returns from these leases, plus the part of their support contributed by the Federal Government, formed their principal means of livelihood. As might be expected under such conditions, individual initiative was not the rule.

The Indian Service is now encouraging these people to become more self-supporting and to raise stock themselves instead of leasing their lands. This change from lessors to operators means changes in the attitude of the Indians as well as in methods of operating the land, and many practices designed to conserve the range and pasture lands already have been started by the Indian Service. Stock-watering facilities have been increased through the installation of windmills and stock ponds. Additional fence has been built, and portions of the bottomlands have been reseeded for forage increase. A forestry program has been initiated to ensure a dependable supply of fence posts and firewood.

The presence or lack of irrigation water in the West is always a determining factor in land use. Only 17,000 out of a total of nearly 300,000 acres in the reservation had been developed for the production of irrigated meadow, pasture, and hay crops, and hence it was apparent that there was great need for more irrigation water. This condition has been alleviated by the completion of Wild Horse Dam, a project of the Bureau of Irrigation of the Indian Service. The dam will supply sufficient water for the irrigation of approximately 26,000 acres. Miles of irrigation canals with their network of laterals now carry the water from the dam to the once arid lands.

These newly irrigated lands presented many conservation problems. Besides the determining of crops required by the reservation, it was necessary that careful consideration be given to the correct placement of forage species for each site and circumstance encountered. A study of the reservation and its conservation problems emphasized the need for many adjustments in land use as well as for improvement in soil-management and cropping practices. The range in general was found to be in good condition, although certain areas, because of their accessibility, had been over-utilized. The over-utilization was the result in part of the lack of divisional fences and watering facilities.

Although the range lands were capable of supporting more stock than was being carried at the time the survey was made, the observations indicated a pressing need for additional green finishing feed as well as for winter hay. Because of shortage of supplemental feed, stock had been turned out on the range too early in the spring and kept on the range too late in the fall.

Because of the high water table on certain bottomlands, moisture conditions were found to be unfavorable for maximum crop production, and, aggravating this condition, was the practice on some of these lands of applying irrigation water for long periods. This over-irrigation discouraged the more valuable forage species, and was favorable to the intrusion of undesirable weeds.

Many of the alfalfa fields, although located on adaptable sites, had relatively thin stands, and cheatgrass had intruded, lowering both the production and quality of the hay. Also, in some instances, crops were being planted on sites where soil and moisture conditions were not favorable for their best growth.

The plan of conservation for this reservation includes numerous practices, all of which contribute toward a sound livestock enterprise and permanent agriculture. In putting this plan into operation, the Indian Service supplies labor, equipment, and a proportionate share of materials. The contribution of the Soil Conservation Service is largely one of technical assistance and supervision, although certain materials not available from the Indian Service will be furnished. On the range, boundary fences will be completed and the existing fences repaired or replaced. Division

Stacks of hay for supplemental feed.

fences will be constructed, permitting the proper distribution of stock in accordance with range conditions. Springs and wells will be developed and stock ponds and tanks started by the Indian Service will be completed and others constructed. The ponds will be of value to wildlife as well as livestock.

The agronomic plan for these 26,000 acres of irrigable lands, which form the key to the use of nearly 300,000 acres of surrounding range, has been designed to fit into the broad conservation program. Seeding and reseeding to pasture and permanent hay will proceed at the rate of about 2,000 acres a year until the point is reached where further expansion is undesirable or unnecessary. Reseeding on the reservation by the Indian Service has demonstrated that with proper care and management the forage production on the present croplands may be increased to a considerable extent.

The various aspects of the agronomic plan are given priority in respect to economic needs, availability of funds, etc. The most productive lands will receive first consideration. As the program develops, thousands of arid acres covered with sagebrush, but subject to irrigation, will be cleared. Beginning in the spring of 1940, about 1,400 acres of wet bottomland will be renovated. Reseeding will be necessary, involving the use of moisture-tolerant species that will provide hay and pasture. Specified for this use are redtop (*Agrostis alba*), meadow fescue (*Festuca elatior*), alsike clover (*Trifolium hybridum*), timothy (*Phleum pratense*), and Reed's canary grass (*Phalaris arundinacea*). A mixture composed of redtop, timothy, and alsike clover will constitute the largest plantings. Approved agronomic and soil-management practices will be applied, and judicious use of irrigation water will do much toward maintaining the desired vegetative composition. Water saved in this manner can be effectively utilized on the many arid acres. Drainage ditches will be installed in strategic areas by the Indian Service.

In thin stands of alfalfa where cheatgrass has intruded, the program provides for the interseeding of forage grasses to discourage growth of cheatgrass and at the same time improve the production and quality of hay. Since the hay produced is not sold outside of the reservation, an alfalfa-grass mixture is quite acceptable to the Indians and provides a well-balanced forage for stock. The alfalfa fields are pastured during the fall and, with grass in the composition, the danger of bloat is largely eliminated. About 460 acres of alfalfa will be treated in this manner, using interseeding of smooth brome (*Bromus inermis*), orchard grass (*Dactylis glomerata*), and meadow fescue (*Festuca elatior*) in mixture.

At the time of survey, about 70 acres were devoted to the production of cereal crops. However, inasmuch as there is an urgent need for greater production of both cereal hay and grain, provision has been made for an increase of these crops by growing them in rotation

(Continued on p. 282)

SOIL CONSERVATION IN TUNG ORCHARDS

By GEORGE N. SPARROW [1]

A DISMAL future seemed predestined for five small tung trees that found their home in the soil near Tallahassee, Fla., on November 15, 1906. Orphans in a strange land far removed from their parentage in distant China, their culture, wants, and needs were unknown to their friendly but perhaps none-too-hopeful guardians. Four of the trees were unable to cope with the strange circumstances of life in a foreign land. Adversities of weather and soil—and perhaps culture—brought an end to their existence.

The fifth tree survived and reached maturity. In 1913 its nuts produced 2$\frac{2}{10}$ gallons of tung oil, the first such oil to be produced in the United States. That tree still stands—symbolic of the beginning of a new American industry, the future of which is still clouded with skepticism on one hand and with over enthusiasm and get-rich-quick schemes on the other.[2] A middle road of cautious and sane entry into the business—and a number of growers seem to be following that road—is indicated as the proper route to follow, when guided by planned research, to eventual success.

[1] Area engineer, Southeastern Region, Soil Conservation Service, Tallahassee, Fla.

[2] Two other trees living today were also a part of this original lot of trees. One of them stands at Marlow, Baldwin County, Ala., having been planted by the late Ambrose Bardeau. The other was planted by Carl Purdy on his ranch at Ukiah Calif.—*Editor.*

In China, the native habitat of the tung tree (*Aleurites fordii*), little information is recorded of the culture and requirements of the tree. It is reported that tung trees in that country bear a small crop the third year after planting, with increasing yields the fourth, fifth, and sixth years. According to a report on tung culture in West Central China by H. Liu, of the Chemical Research Laboratory, the average maximum useful life of the tung tree is about 20 years. After that age the tung tree ceases to bear fruit, as a result of erosion and exhaustion of fertility in the soil. Under the most favorable natural conditions a tung tree may live over 50 years, but it is no longer productive at that age.

It is probable that the first tung seeds to produce trees in America were imported in 1905 when the Plant Introduction Garden of the United States Department of Agriculture at Chico, Calif., received nuts from the Consul General at Hankow, China. Five 1-year-old seedlings were sent from California to Florida in 1906. In 1911 the first bushel of unshelled nuts or seeds was produced near Tallahassee, Fla. In 1913 the first American-produced tung oil was extracted. By 1915 tung trees had been planted on 40 acres of land near Tallahassee. That planting met

A mature tung orchard.

with such adverse weather conditions that the owner practically abandoned it. About 1925 the orchard was partially rejuvenated by the application of fertilizer and the yield increased. Commercial plantings of tung trees began about 1923. The establishment of new sources of tung oil appeared necessary, as is indicated in the following quotation from the North China Standard, published at Peking, November 14, 1923: "Unless political and commercial stability soon return to Szechwan, American varnish manufacturers may be compelled to seek another source for their raw products and may even have to change their processes in order to use other products." Recent historic events indicate that the situation, instead of improving, has probably become much worse in war-ravaged China. So, with typically American expedition, capital investment in the tung tree in the United States becomes larger each year. According to reliable estimates, approximately 175,000 acres have already been planted to tung trees. Some authorities contend that from 25 to 50 percent of the acreage now planted will never be productive, because of unfavorable sites and soils.

There is a definite demand for tung oil as a raw material in American manufacture. It is used in the production of varnish, enamel paint, flat wall paint, paint driers, and, with rosin, in waterproof varnish. It is used for waterproofing and with aluminum oxide is made into aluminum tungate for both fireproofing and waterproofing. The electrical industry employs tung oil in insulating compounds and the automobile industry in the making of brake lining and of undercoats in body finishes. Many other uses are also being made of the oil. In 1937 importations of tung oil from China amounted to 175,000,000 pounds, representing a foreign expenditure of $15,000,000 of American capital. Present American production, however, is small compared with the amount used, approximately 4,000,000 pounds of tung oil having been produced in this country in the high-production year of 1938.

Potentialities of the new industry are therefore considered great in the light of present consumption in contrast to present American production. It has not yet been demonstrated, however, that American growers can produce tung oil at a profit in competition with tung oil imported from China and with the other oils used for the same or similar purposes. Prospective growers of tung oil have been warned against blind and promiscuous entry into the business. A considerable number of plantings have already been abandoned because the growers knew too little about

Tung trees grow fast. This one was seeded eight months before the picture was made.

the tree and its requirements. In the United States the tung tree cannot be planted and left alone to mature and produce. Results from such treatment have been very disappointing. Like other orchard plants, the tung tree demands certain requisites of soil, climate, fertility, and general culture.

Much research and experimentation in tung-oil production is needed for proper orientation of the business. Valuable information has already been obtained, while the industry is yet in the formative stage. During the years after the introduction of the tung tree in Florida, experiments were conducted at the Florida Experiment Station at Gainesville. The results from those experiments have already saved orchards seemingly destined for abandonment. One striking example of the experimental work was the discovery of zinc as a

requirement of tung trees and the development of corrective procedures to supply deficiencies. The value of research to the industry has been proved.

Federal appropriations have been made for experimental work with tung oil on a wider scale, and work by the Bureau of Plant Industry and the Bureau of Agricultural Chemistry and Engineering is under way. Agronomic research will involve experimentation in varieties, planting, cultivation, fertilizers, harvesting, breeding, methods of propagation, and so on. Other research will embody a study of the harvested fruit and nuts as to content, characteristics, and production of the oil. A study of uses and byproducts will also be made. All of the research is to be closely correlated.

The Soil Conservation Service has had an opportunity to work with growers in Florida in the establishment of orchards as a part of the demonstration phase of the Service program. A problem of soil conservation and of orchard planning along conservation lines prior to planting confronts growers in certain localities. On and adjacent to the Soil Conservation Service demonstration project near Monticello, Fla., a 2,000-acre orchard of tung trees has been planned and planted toward the end of conserving the soil as well as producing tung oil.

American growers of tung trees are expecting a much longer productive life from the tree than is reported from China. There seems to be little indication that fertilized orchards reach a peak of production the sixth year only to decline in production thereafter. Instead, the orchard is considered at that period of its life as just becoming a paying proposition and as entering into the prime of its existence as far as production is concerned. Coordinated effort of growers and agricultural agencies, however, is already determining certain peculiarities of the tree. Doubtless, much information will be forthcoming.

American progress is marked by the improvement of industry and agriculture. New industries have profited by the shortcomings of older industries and the older industries which have withstood the test of time have profited by correcting their own mistakes. "Field observations indicate that some of the most serious erosion in the country occurs in the peach orchards in the South and East and in some of the square-planted, irrigated orchards of the West." [3] With the present knowledge of soil-conservation methods it would be foolhardy for the exponents of the tung-oil industry not to take full cognizance of the experience of other orchardists. The adaptation of modern methods of soil conservation and orchard management is indicated as vital in the insurance of a permanent tung-oil industry.

It has been rather definitely determined that the tung tree requires an inherently productive soil. Plantings have been made, and are probably continuing to be made, on deep, sandy soils. Economic limitations apparently will not permit the application of nutrients into the poorer soils in sufficient quantity to supply the required fertility. Orchards that show promise of continued productivity or of soon coming into economical production have, for the most part, been planted on better soils. Tung trees appear better adapted to soils having a clay subsoil than to any other type of soil.

The tung tree also requires a well-drained soil. That requirement definitely limits the location of satisfactory orchards to land situated sufficiently above natural drainages—surface or underground—to ensure proper drainage. The combining of the requirements of productive soil and good drainage will result in the location of many plantings on undulating topography which is subject to erosion.

The tung tree is a deciduous plant. In tropical climates it sheds its leaves three or four times each year with very little fruiting. This indicates, therefore, that it is not a tropical plant and must experience cool winter temperatures for a proper rest period. However, fruiting is seriously affected or completely prevented if the bloom is killed by frost. Some wood damage by cold has been observed in young trees in the spring when temperatures have suddenly dropped. Injury from low temperatures depends on the physiological condition of the trees at the time, and the degree of cold experienced. There is a northern limit to the establishment of tung trees. The Gulf Coast States probably offer the most promising locations for the tung-oil industry in the United States. According to reports from China the tung tree is adapted best to hilly country where the altitude is not greater than 2,500 feet. Faced with the late frost hazard which exists even in the Gulf Coast States, many planters are establishing their orchards on areas of sufficient slope to provide some protection from frost. The locations of plantings on such terrain present potential erosion problems.

Many growers hold to the idea that the rectangular or square planting of orchards is the most satisfactory, regardless of the slope of the land. Ease of cultivation and the adaptability to cross-cultivation are the logical bases for establishing such plantings. The contention

[3] From the article, Orchard Conference, by C. L. Hamilton, SOIL CONSERVATION, June 1937.

Aerial view of a seed-planting of tung trees in the Soil Conservation Service demonstration project near Monticello, Fla.

of the exponents of that type of planting is that adequate protection from erosion will be obtained by the use of annual and perennial cover crops. Other growers—particularly those who have located plantings in soil which is definitely erodible under clean-cultivated, row-crop culture—contend that contour plantings of tung trees with channel-type terraces for the systematic control of run-off water are necessary for the conservation of the soil and for the maintenance of soil fertility. Cultivation of such plantings will, of course, be along the contour rows of trees. The latter type of orchard arrangement is considered much better from a soil-conservation standpoint. Its satisfactory adaptation, however, is dependent upon the peculiarities and characteristics of the tung tree.

Numbers of problems have arisen in regard to the arrangement of contour plantations. The usual spacing of tung trees in orchards varies from 25 by 25 feet to 30 by 30 feet. Contour plantings have been made in rows spaced 30 feet apart with tree spacing 20 feet within the row, but it is the opinion of horticulturists that it will be necessary to remove some trees later, or increase the spacing. Careful attention should be given to get proper location of trees to be retained. When normal terrace spacing is used the horizontal interval between terraces varies to such an extent as to cause considerable loss of usable land. Such a loss is unavoidable as long as tree spacing is kept constant and as long as terrace spacing must follow some empirical rule. Varying the vertical spacing of terraces from accepted standards, within limits, to secure more economical horizontal spacing of the terraces has been used rather generally in one orchard. The practice is considered sound for several reasons. Consistent cultivation of tree rows will inevitably build a ridge along each row. The water-retaining capacity of each row, and the filtration of run-off and the water-detention furnished by cover crops between rows should normally reduce the expected burden on each terrace.

The arrangement of tree rows adjacent to terraces has been a matter of some contention. The normal arrangement has been that of establishing rows parallel to terraces and placing the short rows near the midpoint of the terrace interval. With the placement of one tree row practically on the crest of each terrace there would be sufficient distance between that row and the next row up the hill from the terrace to pro-

vide for satisfactory maintenance of the terrace. One grower contended, however, that such an arrangement was dangerous because the plowing required for terrace maintenance might be detrimental to the trees on the terrace. Cultivation of the tung tree must be shallow in order not to destroy the myriad feeder roots that develop very close to the surface of the soil. Faced with that danger, the grower considered it wiser to place his terraces approximately halfway between tree rows in order that each tree row in his grove could receive like cultivation. Further knowledge of the tree and its cultural requirements may determine whether the grower was unduly alarmed or not.

Of importance in terracing and contour planting an orchard of tung trees is the matter of field roads. In large orchards heavy cultivating equipment and large transportation units will be employed. Loads of tung fruit must be hauled at harvest from the orchard to expression plants or warehouses. Access must therefore be provided to each terrace interval and each tree row without damage to the water-disposal system and with efficient arrangement for vehicular transportation.

In contour plantations the planting of cover crops—leguminous or nonleguminous, annual or perennial—affords a pattern similar to that of strip cropping and with the same ultimate benefit as strip cropping, except that the strips will not vary as to location. Leguminous summer cover crops of *Crotalaria spectabilis*, *Crotalaria intermedia*, *Crotalaria striata*, and cowpeas are proving satisfactory in young orchards but may not prove satisfactory in older orchards unless the trees are widely spaced. Austrian winter peas, vetch, and lupines are proposed for leguminous cover during the winter months. Cultivated grasses and native vegetation are proposed for summer nonleguminous cover, while oats are expected to be grown during the winter. Strips of kudzu are being planted on the most erodible soils and steeper slopes to provide perennial cover and hay. Kudzu is also to be utilized for water-disposal areas and for meadow strips for water disposal.

The use of cover crops is, of course, an excellent practice insofar as conservation of the soil is concerned. Leguminous cover crops are also being tried in tung plantations to determine the effectiveness of this method of improving crop production. Results indicate that the practice is sound.

A number of schools of thought have arisen in regard to tung tree culture. Exponents of each are investing capital along the lines of their convictions. Careful seed selection from trees known to be good bearers generally is considered wise. From that point on, opinions differ. Some growers contend that earlier satisfactory production is obtained by orchard plantings of the seed. Others contend that seedling trees should be produced in the nursery and transplanted in the orchards as one-year-old trees. Considerable interest is being manifested in asexual methods of propagation, such as budding and grafting.

A supplemental industry for tung growers is that of cattle production. Some growers expect to have their cattle range the orchard and thus to obtain extra benefits from palatable cover crops. Such a practice is not generally recommended in young orchards because of the damage to the trees by cattle promiscuously trampling and breaking them. Extra feed in the form of hay and grain can be produced in water-disposal areas and in strips between tree rows but undoubtedly the latter would reduce tree growth and also the nut crop. Complete planning of the farm can usually provide improved pastures in the lowlands which are unsuited for the growth of tung trees.

Bibliography

1. Research on Tung Oil, an address by Dr. Henry G. Knight, Chief, Bureau of Chemistry and Soils, United States Department of Agriculture. Released March 28, 1939.
2. The Tung-Oil Tree, by Wilmon Newell, Harold Mowry, and R. M. Barnette; revised by A. F. Camp and R. D. Dickey, Bulletin No. 280, Agricultural Experiment Station, University of Florida. June 1935.
3. A Preliminary Report on Frenching of Tung Trees, by Walter Reuther and R. D. Dickey. Bulletin No. 318, Agricultural Experiment Station, University of Florida. December 1937.
4. A Preliminary Report on Zinc Sulphate as a Corrective for Bronzing of Tung Trees, by Harold Mowry and A. F. Camp. Bulletin No. 273, Agricultural Experiment Station, University of Florida. December 1934.
5. Tung Oil Industry in Florida (Revised), by Federal Writers' Project of Florida under W. T. Martin, associate editor, New Series No. 11, Department of Agriculture, State of Florida.

STATUS OF DISTRICTS

In August 1937, 2½ years ago, the first soil conservation district was formed by farmers in Anson and Union Counties, N. C. Today, there are 234 such districts, covering nearly 128 million acres of land, in 26 States. Over a million farmers are cooperating with the districts in fighting erosion. The United States Department of Agriculture is at present cooperating with 171 districts, embracing 97 million acres. The Soil Conservation Service is providing the technical assistance for drawing up farm plans and the C. C. C. camp labor where it is available.

ECONOMIC ADVANTAGES AND LIMITATIONS OF SOIL CONSERVATION ON ILLINOIS FARMS

By E. L. SAUER [1]

SIGNIFICANT results are being obtained from a cooperative study in Illinois to examine the economic effects of a soil conservation program, and to ascertain and analyze factors of good farming under soil-conserving conditions.[2] Detailed farm records are being kept on farms cooperating with the Soil Conservation Service in its demonstration program and also on neighboring farms that are following the usual systems of farming.

During the 4 years, 1935 to 1938, comparative economic studies have been carried on in the three Soil Conservation Service project areas in Illinois (Le Roy, Edwardsville, and Freeport) and in two Soil Conservation Service camp work areas (Marion and Aledo). In the Le Roy area, where farm records have been kept since 1935, farms cooperating with the Service program were matched, insofar as possible, with neighboring noncooperating farms on the bases of number of acres, soil ratings, proportions of land tillable, and land valuations.

While normally 3 to 5 or more years are required to establish completely a soil-conserving system of farming, account records covering in all cases 1 to 4 years after the program was initiated already show striking results in an economic comparison of cooperators and noncooperators. By 1938, cooperating farms in the Le Roy area had improved materially over those employing the usual system of cultivation (see table 1).

TABLE 1.—*Trends in land use, cooperating and noncooperating farms*

Year	Proportion of tillable land in grain crops		Proportion of tillable land in hay and pasture		Proportion of tillable land in soil-building legumes	
	Cooperators	Noncooperators	Cooperators	Noncooperators	Cooperators	Noncooperators
1935	77.8	86.5	22.2	13.5	8.8	2.7
1936	73.6	88.2	26.4	11.8	15.9	4.8
1937	71.7	91.4	28.3	8.6	13.8	3.1
1938	77.0	83.5	23.0	16.5	16.2	8.9

Thirty-nine cooperating farms, following a planned program of soil-erosion control, were developing during this time a much sounder land-use system from the standpoint of a permanent agriculture than that of 33 neighboring farms not following a planned program of soil-erosion control. These cooperating farms grew less corn, oats, wheat, and soybeans, acre for acre, than their neighbors, and still had higher incomes. In 1938, the conservation farmers had in soil-building legumes almost twice as much tillable land as noncooperators. Upward trends in hay and pasture and in soil-building legumes for noncooperators in 1938 were due to increased participation in the A. A. A. program and the adoption of some of the practices observed on farms of Soil Conservation Service cooperators.

Improved rotations (including the use of green-manure crops), applications of limestone, phosphate, and fertilizer as well as a larger amount of animal manure, and soil-conserving practices such as contour farming, strip cropping, terracing, and use of buffer strips and grass waterways, were reflected in substantial improvement in crop yields on cooperating farms as compared with noncooperating farms (table 2).

TABLE 2.—*Trends in crop yields on cooperating and noncooperating farms*

Year	Corn, bushels per acre		Oats, bushels per acre		Soybeans, bushels per acre	
	Cooperators	Noncooperators	Cooperators	Noncooperators	Cooperators	Noncooperators
1935	49.8	47.2	32.5	29.8	16.8	19.4
1936	29.5	27.7	25.2	25.7	18.4	18.5
1937	55.6	48.8	51.5	48.3	22.2	19.6
1938	54.6	48.4	35.5	31.5	28.2	21.9

These crop yields on conservation farms represent the improvement attained while the planned program is still in its early stages. It is expected that in the future the long-time results of following a good system of land use will be even more significant than results secured in the first 4 years of this study.

By 1938, livestock was playing a relatively more important part than in 1935 in the higher earnings obtained on cooperating farms. As compared with noncooperators, these farms had larger investments in livestock, fed more feed, and were more efficient in feeding operations. In 1938, cooperating farms fed feed valued at $1,169 (exclusive of pasture) to productive livestock as compared with $692 for farms following the old system. In 1935, cooperators fed

[1] Economic research representative, Soil Conservation Service, at the University of Illinois, Urbana, Ill.

[2] The Department of Agricultural Economics of the University of Illinois, the Soil Conservation Service, and the Bureau of Agricultural Economics of the U. S. Department of Agriculture are the cooperating parties.

222612—40——2

EDITOR'S NOTE.—Mr. Sauer's article is based on a broadcast entitled "Soil Erosion Control and Farm Earnings" presented over Station WILL on Friday, June 30, 1939, by Prof. M. L. Mosher, of the Department of Agricultural Economics, University of Illinois, and the author.

feed valued at $1,007, and noncooperators $772. With more roughage produced as a result of the conservation program, operators of conservation farms naturally increased the number of roughage-consuming livestock in order to utilize forage crops most profitably. Good soil-building legumes used in hay and pasture mixtures on cooperating farms resulted in higher quality roughages and hence in more effective livestock gains from the point of view of efficient farming.

The data in table 3 indicate a close relationship between legumes, livestock, and crop yields. Sufficient legumes in the cropping system, combined with enough livestock to make economic use of the legumes, proved profitable on farms included in a long-time farm account study in Illinois.[3] The data show that at the start of the 10-year period, the farms with the most legumes and livestock had an average advantage of 2.9 bushels of corn per acre, and at the end of the period they had an average advantage of 9.4 bushels per acre.

TABLE 3.—*Percent of tillable land in soil-building legumes, amount of livestock fed, and corn yields on 57 central Illinois farms, 1925–34*

Item	20 farms with most legumes and livestock	20 farms with least legumes and livestock
Percent of tillable land in soil-building legumes	21.4	11.1
Feed fed per acre to livestock	$13.55	$6.88
Corn yields per acre:		
Average, 1925, 1926, and 1927	51.9	49.0
Average, 1932, 1933, and 1934	49.9	40.5
Average, 1925–34	49.5	45.0

Average costs for man labor, horse labor, and machinery per crop-acre, were somewhat higher on cooperating farms during 2 of the first 3 years of the study. By 1938, however, there was no significant difference in these items on the two groups of farms.[4] Total operating expenses per acre in that year were $10.83 on cooperating farms and $10.84 on noncooperating farms. These operating expenses include the annual charge for limestone and phosphate applied in 1938 and in previous years, as well as all other operating expenses such as those for machinery, equipment, labor, seeds, fencing, building repairs, taxes, and miscellaneous items.

Based on the records, it appears that after initial improvement is made, soil conservation practices such as strip cropping, contour farming, farming with terraces, the establishment and maintenance of grassed waterways, and the adoption and following of a good system of land use have not increased total farm operating expenses. Costs of materials furnished by the Soil Conservation Service, such as limestone, fertilizer, seeds, and fencing and charges for the use of terracing machinery, C. C. C. labor, and Service technicians' time, have not been included in the farm operating expenses on the Soil Conservation Service cooperators' farms as shown in table 4. These costs, if spread over a period of 3 to 5 years, would be relatively low compared to the regular operating expenses of the farm. The data secured in this study as well as data from long-time farm record studies in Illinois indicate that if higher costs occur in the years when the program is being inaugurated, these costs are likely to be more than offset by increased returns in later years as the soil improvement program becomes effective and as losses from soil erosion are brought under control.

The real test of the feasibility of conservation is a determination of net returns in dollars and cents, and here again the cooperating farms have shown better results. They had larger gross incomes and their expenses were no higher; hence their net incomes were larger than those of noncooperating farms as may be seen in table 4.

TABLE 4.—*Gross income, total expenses, and net income on cooperating and noncooperating farms*

Year	Gross income per acre		Total expenses per acre		Net income per acre	
	Cooperators	Non cooperators	Cooperators*	Noncooperators	Cooperators	Noncooperators
1935	$14.86	$13.91	$8.57	$9.11	$6.29	$4.80
1936	21.55	19.67	9.77	9.73	11.78	9.94
1937	20.44	16.81	10.54	10.27	9.90	6.54
1938	18.40	15.87	10.83	10.84	7.57	5.03

*Contributions of Soil Conservation Service not included.

Based on the average-sized farm in this study (193 acres), cooperating farms in 1935, the first year the program was underway, had an advantage in net income of $288 per farm; in 1936, $355 per farm; in 1937, $648 per farm; and in 1938, $490 per farm. While these data

[3] Farm Practices and Their Effects on Farm Earnings. By M. L. Mosher and H. C. M. Case. University of Illinois. Agricultural Experiment Station Bulletin 444. 1938.

[4] Average costs per crop-acre for man labor, horse labor, and machinery for the 4 years 1935–38 were as follows: cooperators, $8.74, $10.01, $10.92, $10.44; noncooperators, $8.88, $8.79, $9.45, and $10.39.

show that cooperating conservation farms had somewhat higher net returns when the conservation program was inaugurated, they also show that the spread in earning power between conservation and nonconservation farms increased during the 4-year period. The well-planned conservation program, embodying the best use for each acre of the farm, paid dividends for the conservation farmers.

The smaller sample of data available on other Soil Conservation Service demonstration areas under study shows results similar to those obtained in the Le Roy area. In fact, the farm record studies made to date indicate that a planned program of soil conservation and erosion control not only makes possible higher farm incomes, but also provides for maintenance and improvement of soil resources and for farm improvements, thus adding to the capital assets of farms.

The higher incomes possible under the individual farm programs are, of course, predicated upon prices for farm products being maintained at fair levels.

The available economic data provide a strong argument in favor of conservation farming under Illinois conditions; in fact, they indicate that a farmer cannot afford to disregard such a program. Paradoxically, those farmers who have been in most urgent need of soil-conserving measures for the most part could not afford to adopt such a program. The chief reason for this is that current income has not been large enough to enable them to meet current operating and living expenses (including the payment of interest and indebtedness) and at the same time provide for the initiation of a soil conservation program which of necessity requires long-term planning. An outlay of cash, a source of credit, or government aid is usually necessary to enable farmers to take the initial step in a planned program of soil conservation and erosion control. On the majority of those farms that need to adopt a conservation program, the principal help available to farmers is that provided by the A. A. A. program, with payments for specific soil-building practices. Government aid through the Soil Conservation Service is tapering off as demonstrational phases of the program are drawn to a close, and at best this aid is limited to the project and demonstration work areas and soil-conservation districts.

In all the Soil Conservation Service demonstration areas in Illinois where farm records were secured, the low-income farms (in most instances farms that were badly eroded and in a low state of productivity) did not have large enough incomes to permit that much if anything be spent in the inauguration and adoption of a conservation system of farming. This is illustrated by the "cash farm balance" (cash available for farm family living expenses, interest payments, debt retirement, etc.) on the low-earning one-third of the farm account keepers' farms for 1937, the most representative of the 4 years, 1935–38. This balance averaged per farm for the several areas as follows: Le Roy area, $868; Edwardsville area, $764; Freeport area, $1,037; Aledo area, $272; and Marion area, $43. In connection with these data, it should be realized that farm account keepers represent better-than-average farmers in their communities. Considering the heavy indebtedness on many of these farms, together with the fact that a large proportion are tenant operated and that this cash balance must be divided between tenant and owner, it can readily be seen that limited available cash is a serious deterrent to the individual farmer's inauguration of a program of soil conservation and erosion control.

The farm record studies have demonstrated the economic advantages of a planned program of soil conservation. They have also pointed out the fact that in many instances such a program is not economically possible since full benefits may not be realized for a number of years.

A NOTE ON KUDZU

In less than a decade kudzu, introduced from Japan some 50 years ago and commonly called a "porch vine," has been transformed into an important field crop in the Southeast. Since the beginning of erosion-control projects, more than 40,000 acres of eroded land have been planted to this once ornamental plant.

Kudzu is especially adapted to Southeastern soil and climatic conditions and is not seriously affected by droughts. It will not grow well, however, on poorly drained areas of acid soils or on low marshy lands. The plant is a deciduous, viney legume which grows rapidly during spring and summer months. Kudzu restores fertility to the soil by adding nitrogen and organic matter and it maintains a stand over long periods without yearly soil preparation and planting. It grows vigorously on eroded land after it is well established and with a dense ground cover kudzu protects the soil against beating rains. Not only is kudzu especially suited to reclaim badly eroded slopes in cultivated fields, but it also produces a palatable hay and forage of excellent quality; its feeding value is as high as that of alfalfa and produces larger yields than most annual plants grown for hay. Kudzu can easily be eradicated, thus eliminating the danger of becoming a pest.

STORY OF AN OHIO FARM

COSMOS D. BLUBAUGH worked for years to save enough money to buy an eroding, hill-land farm in his native Knox County, Ohio. His early struggles with erosion and his eventual triumph—his farm today is ranked as an outstanding example in soil conservation—are told here by Mr. Blubaugh.

"We bought this hill farm in 1924. Men who enjoy the feel of earth under their feet will know why I wanted to farm. It took us more than 10 years to learn that we were not treating our land right. We watched heavy rains roll down over our plowed fields, taking off our lime and phosphate and the manure we had applied to clinch the deal for a set of clover. I had paid $40 an acre, and I was losing the most valuable part of my investment—the soil.

"In 1935 Knox County had the good fortune to obtain a soil conservation C. C. C. camp. I visited the demonstration area and asked for the assistance of technicians in replanning to prevent erosion. They took out fences, laid out the farm in contour strips, and recommended that the remaining 17 acres be used for permanent pasture. The pasture was treated with 2 tons of limestone and 300 pounds of superphosphate, and in 1938 it carried 2 units of livestock per acre.

"Contour farming has increased our corn yield from 15 to 25 bushels an acre, and the only water and soil loss is in old gullies; even that is caught in the grass strip below. We top-dress our new wheat seeding: With a heavily loaded spreader it is an advantage to follow around the hill, on the contour. We do not combine our small grains—straw is important.

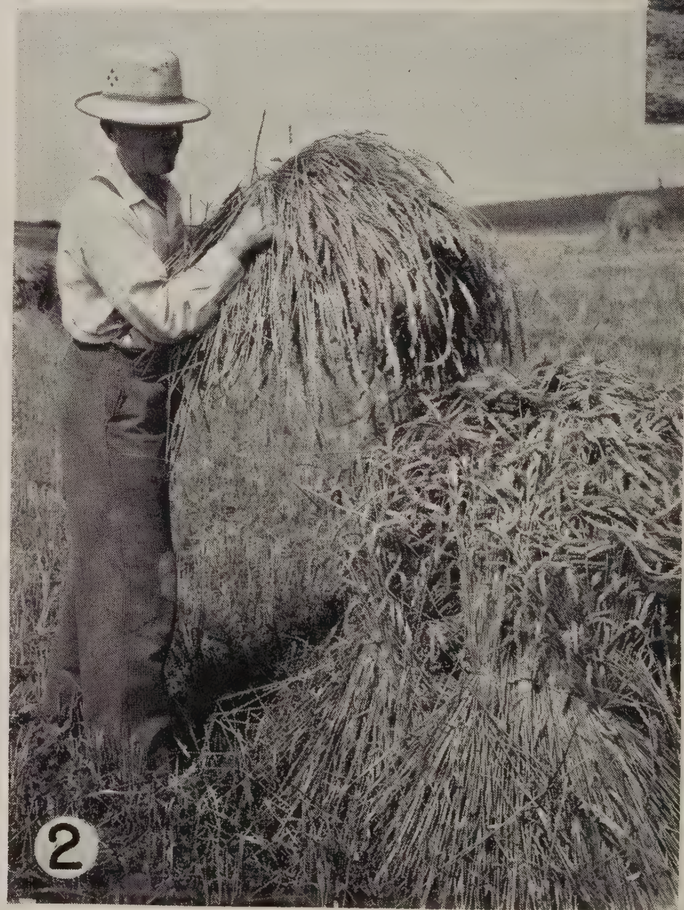
"Rows in our new orchard are on the contour. We planted those trees. Our second son is the orchardist in the family partnership. My wife and I take care of the raspberry patch, along with the garden, and every row is on the contour even though the land doesn't slope much. Some soil on this farm is a little porous and sandy and we save all the water that falls.

"We have a 35-acre woodlot. The barn is the only old building still in use; all others were made from lumber from the woodlot. We take good care of the woodlot and no part of the farm pays any more profit. We purchased an adjoining farm this year which is even more hilly. Already it is all laid out in contour strips. We were reared in the hills and the hills are home. Now that we can watch the contour strips hold the soil and water when it rains we would not leave our hill farm for level land."

1. Using the hay loader to harvest a fine meadow. Little difficulty is encountered by heavy machinery such as hay loader, tractor, and combine on the contoured fields of the Blubaugh farm.

2. Mr. Blubaugh tosses the cap sheaf on a shock of wheat, a crop which fits admirably into the contour pattern of his farm.

3. Cosmos Blubaugh cultivates strawberries. The rows wind gracefully across the slopes. The furrows empty surplus water into well-sodded waterways.



4. No farm plan is complete until the water supply is assured. The scheme devised by the Soil Conservation Service provided this reservoir. The clear, silt-strained water serves many purposes, among them the spraying of orchards and gardens.

5. Mr. and Mrs. Blubaugh are in partnership with their three sons, Augustus, Edward, and Joe. They also trade work with their son-in-law and neighbor, J. L. Finan. Here Mr. Finan is helping spray the Blubaugh raspberries, newly planted on the contour.

6. The garden truck and berries are chief responsibilities of Cosmos and Lucy Blubaugh. Excellent returns are enjoyed from strawberries and blackberries.

7. The Blubaugh wheat seems better now that it is grown on the contour, a style of farming that provides more water for the plants and keeps the food elements in the soil. Blubaugh keeps careful farm records, as reflected by this weighing scene at wheat harvest.

A SOCIOLOGICAL VIEW OF SOIL CONSERVATION

By OTIS DURANT DUNCAN [1]

IN A HALFWAY serious frame of mind a few months ago I made the statement to a group of people who were interested in rural education that it was possible to judge the psychological, physical, social, and economic characteristics of the farm people in a given area by the size of the earthworms found in the particular vicinity. If the earthworms are as large as a new lead pencil and as red as a piece of round steak, the people themselves, it was pointed out, will be robust and happy, optimistic and cheerful, peaceable, economically independent, self-reliant, self-respecting, and not only literate but also well informed on the everyday affairs of both individual and public life. If, however, the earthworms are as small as a match and as pale as the breast meat of an anemic chicken, the opposite will be true. The people will be quarrelsome, suspicious, gloomy, narrow-minded, illiterate, ignorant; sallow and emaciated with big joints and bony cheeks; they will have wide, thin, transparent ears, and their faces will peer out from under shocks of shaggy hair. I did not intend the statement to "take," but several persons actually wrote it down in their notebooks.

No scientific validity can be claimed for such a hypothesis, of course. But it is unquestionable that the better classes of soils will support a more luxuriant growth of both flora and fauna than will thin, poor soil under similar climatic and rainfall conditions. It would be fallacious to attempt to compare the relative fertility, or the capacities of two grades of soil for supporting human populations on the basis of any one organism found in them. However, when all the organisms living in each of two or more different soils are taken together, the results should be at least a rough indicator of their relative fertility. It stands to reason, then, that the same food elements which produce growth in plants and animals are required for human populations. It is apparent, therefore, that under favorable climatic conditions the soils capable of supporting the heaviest growths of flora and fauna are likewise more desirable for the human population than thin, infertile soils.

It must be recognized that other factors besides that of sheer native fertility of soil are important from a social point of view. First, the location of land is a primary consideration. For a human population to survive on land, it must have inlets and outlets, or accessibility to transportation and communication facilities. At the present time, a civilization can scarcely exist under conditions of utter isolation. Also, the value of farm land for human occupancy is enhanced by nearness to markets, schools, churches, health facilities, and governmental agencies such as the courts and the police. Second, the fertility of land must be interpreted relatively. A thin yellow loamy post-oak ridge is better land for producing sorghum for molasses than is black waxy river bottomland, but the latter is far superior to the former for the production of sugarcane. In other words, the fertility of land depends upon its intended use. Third, there are many hazards which, regardless of the land's inherent qualities, render it unsuitable for human occupancy. These are the danger of floods, and the frequency of other natural catastrophies; erodibility as determined by soil texture, slope, and rainfall; the presence of pests such as hookworm and malaria, and other forms of water and soil pollution. The presence of such hazards as these often may offer obstacles to human beings which are more insuperable than the original lack of plant food in the land.

The time has come when it is necessary for us to become cognizant of a very important fact. The ultimate motive for soil conservation is human conservation. Soil is worthless except insofar as it may be made conducive to human welfare. The Indians sold Manhattan Island for $24. To them that was a good price because they did not know how to put the Island to an effective use. It was virtually worthless to them, and by no stretch of the imagination could they have made it more valuable since they determined its value in terms of their own socio-economic system. As a hunting ground Manhattan was probably quite poor, and to give it greater value someone had to put it to a use that would contribute to the welfare of a greater number of people than the handful of primitive Indians who owned it originally. What gave the Island its fabulous increment in value was the socio-economic system which was transplanted to it by the white men.

The great enigma of what we call civilization is that with a few possible exceptions the richest farm lands, the deltas, the alluvial plains, and the costal plains,

[1] Head, department of rural sociology and country life, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

support the poorest populations of the world, whether in the United States, Africa, Asia, or elsewhere. This applies to the lowlands, but not necessarily to uplands like the Corn Belt, the Texas Black Prairie, and a few other sections. Why does this condition exist? It is because the lowlands are conducive to a semi-servile, and sometimes a completely servile, agricultural system. They are infested with malaria and other human pets which drive away all those who can escape, and this leaves behind a class of cultivators who are more or less dependent upon the oversight of their lords and masters and are unable to rise from under this feudal yoke once it has been clamped about their necks. Fertility of soil alone does not guarantee human welfare, but the soil and the social system imposed upon it; and it is far easier to improve the soil than to get rid of a diabolical social practice.

The conservation of soils that are in danger of waste from erosion, together with restoration of the productivity of soils that have been depleted by erosion, over-cropping and bad management, constitute a vital phase of the national welfare. Some precautions are necessary, however, in determining whether or not conservation measures should be used. Much land has become denuded and riddled with gullies until it can be restored only by nature's own processes, that is, for some generations to come it should be abandoned to grow up in wild life again. One of the first questions which must be faced, therefore, is whether or not the expenditure necessary to check the erosion would be wise if made. Will it be a paying investment? Obviously, the circumstances of the particular land in question will have to determine the answer to that question.

A second important question to be answered is whether or not the social situation demands that a particular tract of land be treated to prevent erosion and to restore its fertility. Many facts must be known before this can be determined: In what direction is the movement of population proceeding? What is the trend of natural increase of the population? Are other lands available to which the population can be moved more economically than older lands can be restored? What are the trends with respect to agencies of social betterment such as schools, churches, recreational facilities, health agencies, and the like? What is the situation with reference to transportation, markets, trade centers, and health? Is the location of the land one that, except for worn-out soil, would be a more desirable habitat for human beings than other accessible locations? Can the land support the necessary social institutions if restored to a state approximating its virgin fertility?

A third important question hinges upon land uses that may be employed under the existing climatic conditions. Would shifts in farm organization be preferable to the expenditure which would be required for the soil engineering program? Should farm units be enlarged or made smaller? That is, should the farm operations shift from an extensive to an intensive margin or vice versa? Could soil-restoring and erosion-preventing crops be substituted to advantage for the existing crops? Could cultivation practices be changed? In all these questions one of the main objectives is to find ways of reducing unit costs in production and to lower the fixed costs of the farm operation. There are times when the application of more capital to land will pay dividends, and there are times when it is like pouring soapsuds into a sinkhole in the ground. Where changes in the farming system can be initiated at relatively little expense, if such changes are capable of producing the desired result they should be employed rather than more expensive engineering practices.

The problem is to determine which course may be better suited to the problem at hand. This is preeminently an economic problem at the surface, but in a larger sense its significance is sociological, for it is axiomatic that the productivity of any tract of land is limited. If a disproportionate share of the total product must be absorbed by overhead cost, it can only follow that the standard of living of the people on the land will be endangered.

The best we can hope for in America is that an increasing proportion of our farm people will be forced to reside on poor land. There are several reasons for this. First, mechanization of productive processes in many of the Nation's better farming regions has enlarged farm units and thereby has displaced great numbers of people who must go to poorer areas to find land of any kind. Second, the natural increase of the farm population is still more rapid than is required to maintain itself at a stationary level. The excess population must migrate, either to cities or to the marginal agricultural areas, for the reason that the better lands are occupied already. Migration to the cities is not always possible. Further than that, the cities themselves are overcrowded and are pushing their own excess population toward the land, especially in depression periods, wherever it is possible to do so. Third, the land is wearing out with use, and is being wasted by natural forces, especially in areas that were once thought to be suitable only for clean row-crop cultivation.

In the face of these trends we naturally and justifiably ask, What can be done? There is no single answer to all these problems. In the first place, we live in a changing world, and solutions of all our problems are never found because the forces which produce them never remain constant. It is a hypothesis which is not only contrary to fact but also beyond the pale of human possibility to assume that in a universe as large and complex as ours anything can remain unchanged for even a single moment. Some things change more rapidly than others and with greater moments of force, and all changes produce compensating reactions. The reactions produced are frequently unpredictable. Who knows, for example, that the act of terracing slopes and stopping the flow of water down their little rills may not, in time to come, produce untold problems to people hundreds of miles away and to generations yet unborn? Nobody knows, and for that reason a socially feasible soil-conservation policy must be projected from as long time a perspective as possible.

If, then, the preservation of farm land is to be a continuous process in the future, it follows that it must anticipate our needs from a sociological and an economic point of view. If, as doubtless is the case, we face a problem of increasing scarcity of good land, we shall need to devise ways and means for getting the farm population distributed upon the good land that remains in economically sized and sociologically sized units. Certainly, we do not wish to see the gradual strangulation of the farm family which we as Americans have regarded for so long with a patriotic devotion. If we desire to preserve whatever it is we call an American standard of living for the farm population, the economically productive farm land must not be allowed either to go to waste or to be stealthily taken from under the feet of those who would till it.

This presents another question which is partly a soil-conservation problem. It seems ironical to boast of the wealth of America while hundreds of thousands of farm people, and others, are begging for work, or even a place to pitch their wretched camps. On the other hand there are people who are still sufficiently well fed themselves that they violently oppose the idea of "reducing" American farmers to a subsistence level of agriculture. It is a new interpretation of the word "reduce" to have it mean elevate, augment, swell, inflate, raise, or improve, and that is what would happen to large numbers of farm people if they were reduced to a subsistence level. Many of them have no place to lay their heads. The land they could live on, they cannot get, and the land they could get they cannot live on. It is the moral duty of those agencies which have undertaken the task of introducing soil-conserving practices also to grade and classify land so that those who need homes may find them. A few years ago we felt complacent and secure when we read that in revolution-ridden Russia there were 10 million homeless people, the majority being children. That was horrible. But in this country where we are at peace, both within and without, there is much to be unhappy about. Probably there are not 10 million homeless people in the United States; but if there are no more than 10, there are too many. Our problem is not merely to keep the soil from washing down the Mississippi River, but also to prevent our human resources from going with it. The efforts of soil-conservation agencies must not all be spent on demonstration areas which in their virgin state would hardly have fed a sparrow. Miracles belong to the past, and we must direct our energies at those points at which people can live on the land when and if we are successful in saving it.

When we speak of subsistence, we should be certain that we do not imply only an animal existence for those of whom we speak. What is subsistence? Ordinarily, it seems to be thought of as the minimum number of wants that must be gratified in order to sustain life and ensure the biological reproduction of the species. Men cannot hibernate in order to protect themselves from inclement weather, nor can they blossom in new colors with the approach of spring in order to attract associates and companions. In order to meet these emergencies men have built cultures, but to profit by culture is expensive, and still it is indispensable. It seems, therefore, that a sensible definition of subsistence should imply the ability of a family to sustain itself in a state of physiological adequacy, ensuring health and reproductive capacity, without diminishing the economic, cultural, and spiritual advantages handed down to it by the preceding generation.

If we do not anticipate and demand cultural as well as physiological adequacy it means that a population is not sustaining itself because, for example, after a farm has been used beyond its prime, each succeeding year requires greater ingenuity and resourcefulness and better equipment to maintain even a stationary level of living than did the previous years. In other words, unless there is some advancement provided for, retrogression is absolutely inevitable. Moreover, the social environment grows yearly more complex and difficult of comprehension, which in turn means that the population cannot barely subsist for long in a physical sense without making appreciable advance-

ment culturally, at least in a competitive society with open social classes and free individual enterprise.

In conclusion, let it be said that the soil upon which a man lives is one of the most important determinants of the soul that lives within him. Whatever may be the steps necessary for the farmer to take in order to conserve his soil resources, in time he will be compelled either to adopt them or to perish. His will to live is powerful enough to force him to exert the required effort. Increasingly, farmers along with other people are forming a larger conception of the meaning of life in its fullest sense. In order that a full realization of this new concept of life may be effectuated, men are becoming aware that the resources they possess must be used effectively and with the highest possible degree of mechanical efficiency. The efficiency of men, like that of machines, can be measured only in terms of the number of energy units consumed in accomplishing a given amount of useful work. In the farm-management sense, this idea may be expressed as the ratio of the input factors to the output. In a sociological sense, it is more difficult to define because the units are comparatively intangible, but even here it represents the relation between the social energy which must be expended in bringing a group to a given degree of advancement and the resulting cultural accumulation at a point of advancement. In other words, efficiency is the relation between effort exerted and the positive gain accomplished. But, energy is limited and possible achievement is limited. The only way, therefore, in which man can rise on the scale of advancement is by learning how to consume a smaller quantity of energy in attaining a given stage of advancement. Then as men enlarge their spheres of living they must utilize their resources more effectively.

Enlightened self-interest directed by intelligent technical guidance is our greatest assurance that the farmer will gladly lend his assistance in the direction of conserving his soil. All farmers worth mentioning are anxious to spare themselves toil and labor. They are desirous of leisure and opportunity for cultivating their own personal ambitions. They have learned that in their enlarged spheres of living they have acquired new and greater responsibility. They have become aware of their obligations to their grandchildren as well as to their own children. The time was and is no more when every farmer could give his sons homesteads of virgin land when they reached maturity. The family farm is all the land there is now, and only a minority of the farmers have that. The farmer recognizes this as well as anyone, but he is no less anxious than was his own father to give his children the opportunities which in his own estimation they deserve. To do that he rightly feels that he must save his soil which is his chief source of wealth and his prospect for security.

We ask ourselves frequently what goal or criterion may be set up by which we may judge the efforts now being made to save our farm lands. Experts do not agree on the answer to this. However, an inescapable conclusion is that soil-conserving practices should be motivated by two positive objectives: (1) The maintenance of the present farm population in a state of physiological and cultural adequacy, that is providing all the necessities for physical and mental health, and at the same time affording the advantages of education, recreation, and social participation and (2), the preservation of the productive powers of the land itself so that it may be passed on to future generations without deterioration.

Some thinkers and investigators contend that the interests of the individual farmer come into conflict with those of society as a whole on the question of preserving the land for future generations. Such an argument is irrelevant, incompetent, and inconsequential. Does not the very life of the farmer demand that he tithe himself to save his land? Is it in the interest of the farmer that he exploit his land, himself, and his children, in order to turn the proceeds into cash? The cash he can not eat, wear, or take with him when he dies. Is not the individual farmer a part of society in the broader sense? Probably that may be one of the difficulties by which he has been bedeviled for centuries. Even the prospect of an old age spent in helplessness should be sufficient incentive to cause the farmer to desire to conserve his soil so that when he can no longer work for himself he may have a competence by which his independence may be guaranteed.

When all that pertains to soil conservation is said and done, one fact will remain: That the soil is indispensable not merely to the farmer but to everyone else as well. A source of trouble in the past and a danger in the future is that too often the land is thought of as an end in itself rather than a means toward greater ends. We have bought land on which to raise corn with which to feed more hogs with which to buy more land. In all this we have followed the line of least resistance and depended for counsel upon the primitive tradition that he who owned land had something which none could take from him. Little did it matter that we stole it from ourselves

(Continued on p. 284)

COUNTY PLANNING SUMMARY

By D. A. FITZGERALD [1]

FARMERS have accepted the opportunity afforded by the county land-use planning program to participate with technicians and administrators in the democratic development of agricultural plans, policies, and programs through organized community, county, and State planning committees. In the first 12 months after the program was initiated jointly by the Department of Agriculture and land-grant colleges, it reached 1,120 counties in 47 States. Nearly 70,000 farm men and women are cooperating as members of organized county and community planning committees.

Memoranda of understanding between the Bureau of Agricultural Economics and the State agricultural extension services and experiment stations, covering the features of the planning organization and the general types of cooperative work, have been signed in 45 States. All these States have established State land-use planning committees or advisory councils except Tennessee and Kentucky. Additionally, in Illinois, an informal State committee has been organized, although the land-grant college has not yet signed the memorandum of understanding. California and Pennsylvania are the other States that have not yet entered into formal arrangements with the Bureau. In Illinois and California, many of the land-use planning activities proposed by the Department are being performed.

State land-use planning committees vary in both size and composition, depending upon the number of State organizations represented and the number of type-of-farming areas in the State. Arizona, with 12 members, has the smallest committee; New York, the largest, has 48 members. On the 43 State committees now organized, 552 farmers are serving. This is an average of 13 farmers to the committee.

Four Department agencies and two State agencies—the Farm Security Administration, Agricultural Adjustment Administration, Soil Conservation Service, and Bureau of Agricultural Economics, State extension services and experiment stations—are represented on each of the State land-use planning committees. The Public Roads Administration is represented on 39 committees, the Forest Service on 38, the Farm Credit Administration on 14, and the Bureau of Biological Survey on 13. The Extension Service and experiment stations are represented on all State committees. State planning boards and State highway departments are represented on 21 committees each.

Most of the committees have a membership of from 22 to 30 persons. Farmers constitute a majority of the membership of 17 State committees. In 35 States, farmers are the predominant single group. Representatives of the Department of Agriculture outnumber the farmers in 4 States.

About 19,000 farmers are members of organized county planning committees, and nearly 51,000 are serving on 6,807 organized community committees. Farmers predominate in the membership of county committees, with representatives of the Department representing the next largest group in most counties. Community committees almost without exception are made up solely of farm men and women.

Besides the 1,120 counties with county land-use planning committees, there are 75 counties in which planning activities are being conducted by community committees prior to formal organization of county planning committees. Besides, a number of counties have set up county committees, but have not progressed to the stage of establishing formal community committees.

In many instances, farmer members of county and community land-use planning committees are also members of farm security advisory committees, agricultural conservation program committees, production credit committees, and many others. It is estimated that about 200,000 farmers, in addition to members of county or community planning committees, took part in land-use planning meetings held during the 6 months ending December 31, 1939.

The number of meetings held by individual county and community planning committees during the same

[1] Assistant head, division of State and local planning, Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.

6 months varied from one to nine, depending on the stage of the planning work. Some county committees have set up executive and subject-matter subcommittees to give intensive attention to specific phases of the county planning committee's work.

During the fiscal year 1939–40, 1,195 counties were selected for planning. Of these, 388 were designated as "preparatory," 761 as "intensive," and 46 as "unified," to use the vocabulary of the county planning project.

Of the 765 counties chosen for intensive planning at the start of the fiscal year, 566 actually carried on area mapping and classification work prior to January 1, 1940. In 47 of the selected counties, work has not advanced beyond the study of basic information and in 152 others intensive work has not begun. In 225 counties the county and community committees have already finished their area classification maps. In 112 counties the work has progressed to the point where a preliminary draft of the area mapping and classification report is being reviewed by the State land-use planning committee. County reports covering the results of area mapping and classification for 59 counties have been reviewed by the State land-use planning committees and submitted to the Department. These reports are being analyzed and summarized.

To date, 43 of the 46 unified counties have made appreciable progress. Formal progress reports from Wyoming County, N. Y.; Ross County, Ohio; Lewis County, W. Va.; Chittenden County, Vt.; Coos County, Oreg.; Allegany County, Md.; Lee County, Ala.; Caswell County, N. C.; and Culpeper County, Va., including agreements by action agencies to initiate recommendations of the land-use planning committees and statements of action that have been started, have been studied and approved by the Inter-Bureau Coordinating Committee. Committees in about a dozen more counties have submitted either preliminary or final reports proposing unified county programs. These will be ready for presentation to the Inter-Bureau Coordinating Committee in the near future. The other counties are still in the process of preparing plans.

Some 738 recorded instances of results growing out of the land-use planning program during the last 6 months have reached the Department of Agriculture. They occurred in 445 counties in 38 States. These results have been in the nature of conserving natural resources, improvement of rural living conditions, action on school costs and organization, counsel on State and local legislative and administrative policy, adaptation of action programs to local conditions, measures to facilitate coordination of agricultural programs, achievements through cooperative undertakings, and orientation of educational programs.

Land-use planning was not, of course, solely responsible for all of them. In some instances, steps toward solutions probably would have been initiated without it; in others, land-use planning merely provided the additional stimulus needed to obtain results; but in many, the committees identified problems, proposed remedial measures, and sponsored the corrective action.

As examples of the first type of results—conserving natural resources—planning committees assisted in the organization of soil conservation districts in Yell County, Ark.; De Baca County, N. Mex.; Tillamook County, Oreg.; Box Elder County, Utah; Elbert County, Colo.; and Culpeper County, Va. In Quay County, N. Mex., and Marshall County, S. Dak., the boundaries of existing districts were extended.

The part played by the land-use planning committees in sponsoring soil conservation districts has varied from place to place, but in all these counties the committees have studied the erosion problem and recommended that districts be set up. In addition, the committees often have arranged public educational meetings, and committee members have circulated petitions to get the required number of signatures. How well these methods have worked is shown in Box Elder County, Utah, where earlier efforts to form a district had failed.

In a number of counties, the Soil Conservation Service has used the planning reports in drawing up district programs and work plans, and in other instances the planning committees themselves have given advice and aid in drawing up such district programs and plans of work.

In Kootenai County, Idaho, most of the best farm land is owned by Indians but farmed by white people. Erosion, noxious weeds, and depletion of fertility have caused serious problems. As a result of the efforts of the planning committee, the Soil Conservation Service is preparing conservation plans for these farms, and the Office of Indian Affairs has agreed to include these plans in the leases. In Newberry County, S. C., the committee proposed that land along streams be developed as permanent pasture. The Forest Service has agreed to develop its holdings in these areas for this purpose, while the Soil Conservation Service plans to use C. C. C. labor to clear such land. In the same county, the Farm Security Administration, the Soil Conservation Service and Extension Service have decided to give more attention to winter cover crops in their farm plans.

Erosion-Control Lessons From Old-World Experience

VI. FIELD BOUNDARIES IN RURAL ENGLAND

By W. C. LOWDERMILK [1]

DURING a whirlwind period of occupation of a new continent we of the United States have been prodigally wasteful of what at first appeared to be inexhaustible resources of forests, game, and soils. We have pushed the frontiers of new lands westward, ever westward, to the Pacific Ocean. The land is occupied, free lands are gone forever. There are no more new continents to discover and occupy. Rather must we find another frontier in the conservation of our lands under use; such a frontier offers a zest for exploration and achievement no less enthralling and profitable than the wild lands of early frontier days. For upon the realization by each generation of the necessity to safeguard lands and waters does the future well-being of our children's children and our Nation depend. The laws of inheritance in the United States do not provide for primogeniture as in England. We do not have this incentive to take pride in, and to improve an estate during the lifetime of its "owner." Its equivalent is needed; for we must find a way of imposing and accepting the same responsibility for maintaining our lands in a state of sustained productivity from generation to generation.

May we, too, realize that our fences, our barns, our homes, our soils, and our waters are not a possession for our individual exploitation, to use, abuse or destroy at will, but a sacred trust as our link in the chain of generations which connect the past with the present and the future.

Rural England, after centuries of agriculture, is an intimate landscape; it is not wild and untamed as is much of the countryside in the United States. It bears the marks of a land, fashioned and cared for by men's hands, mellowed with time, and now ripened in benevolent maturity.

The field boundaries of rural England seem to be permanent, for they were established so many centuries ago; some are known to date as far back as Roman times. Certainly there has been little change in centuries. One may examine a map, made four centuries ago, of the lands of the Rothamsted Experiment Station in east-central England. When a recent survey map is placed over this old map it is seen that field boundaries have, for the most part, remained identical, although the fields have changed owners from generation to generation.

These ancient field boundaries may be of mossy brick or stone masonry, dripping with dampness and plumed with ferns. Others may be made of countless small pieces of flint or stone, laboriously dissected from the soil through centuries of cultivation, neatly piled, row upon row, and made into miniature Walls of China. These walls meander through valleys and scramble tens of thousands of miles, over hill and dale, representing labor over centuries of time. In countrysides where stone and brick are lacking, other sorts of field boundaries dominate the landscape. In southern and central England luxuriant hedges of beech, hawthorn, English holly, and hazel bush intertwined with bramble or ivy, outline each irregular field, and shelter homes and nests for the birds of the air. These hedges are trimmed tidily, giving the countryside a well-groomed appearance. The huge gnarled vines, moreover, betray their long existence through the centuries. The stem of an ivy vine may be 15 inches in diameter. One often wonders what long-obliterated obstacle caused a boundary to curve or bend, twist or circle. Perhaps it was a big rock, or a huge tree which later was builded into a manor house or a shire church. Though the obstacle has gone long since, the bend of the field boundary remains unchanged.

These hedges have endured so many centuries that some are standing on elevated earthen ridges, several inches to several feet in height, where the earth has been held in place by a mass of roots. The levels of enclosed fields may be inches or feet below the former level of the ground as marked by elevated roots and earthen ridges surrounding the fields. This removal of soil by erosion and shifting by plowing took place so gradually over so long a time that new soil was formed as rapidly as it was worn away—for the fields are still fertile and productive.

Field boundaries have proved to be a social necessity. They represent the agreements between conflicting interests. Strife over the boundaries of fields in England must have come to an end long ago, since the size and shapes of fields have endured century after century as marked by ancient and unmistakable borders. This is an achievement of far-reaching importance. Today enduring boundaries between fields and

---

[1] Assistant chief, Soil Conservation Service, Washington, D. C.

Rural England has aged. Field boundaries, centuries old and winding about, have become bearded with grasses or covered with vines. An English rural scene is never without picturesque trees scattered about over the landscape.

between nations are symbols of peaceful cooperation between individuals and peoples.

More than this, the picturesque field boundaries of England have saved the soils from wastage by erosion. The land is broken into small fields, and runaway waters are stopped or checked at field boundaries of walls and hedges. The wild storm waters do not gather into raging torrents to cut gashes or gullies into the fields to carry away the soil. Wherever the field boundaries lie across the slopes, the fields are benched behind them. The flattened field further safeguards the land against erosion wastage of the soil. Stabilized soils conserve fertilizers and works of soil improvement; they assure a permanency of agriculture which is the pledge of charming hedges and moss-covered walls that border the fields.

It is fitting, in a land where agriculture and land use have been so long subdivided by field boundaries, that England can boast of the oldest agricultural experiment station in the world. For more than 90 years records have been kept on the Broad Balk field plots, showing the comparative treatment of the land and its corresponding responses. It is one of many experiments in land use, to discover how the soil may best be treated with fertilizers and rotations for a sustained production of crops. To this agricultural experiment station, at Harpendon, have come students and scientists from all nations, to seek the agricultural wisdom accumulated in the archives and varied experiments of this institution.

If a nation is to endure into the unknown future, it must provide a permanent agriculture for its people, for the sake of the present and for the future. The land, with its soil and water resources, is one of the most vital and direct links we have with the future, beside our social institutions and blood relationships. If, in this chain, from generation to generation, the lands and waters are held in sacred stewardship, to use, to safeguard, and to improve, and afterwards to pass on in a state of sustained productivity to the future, our civilization may endure and prosper. If, on the other hand, one or more generations prove unfaithful trustees of the land and allow field boundaries to crumble, terraces to break down, soils to wash from the hillsides, and gullies to gouge out the fertile slopes and valleys, and to waste the water resources, they bring a curse of want upon the land. All who seek to work out a living on such despoiled lands are heavy laden with burdens of poverty and lower standards of living, and a population becomes more subject to political and social decadence. An enduring agriculture is the basis of a lasting civilization.

The wastage and loss of the natural resources of the earth, due to the ignorance, negligence, willful destruction, oppression, or carelessness of man, are staggering and beyond all human conception. With increasing populations throughout the world, and with all lands now occupied, the realization that man is continuing to destroy the food capacity of the earth for future generations must arouse thinking people to a new conception of man's relation to the earth. When a nation builds for centuries toward a permanent agriculture as England has done, who can limit

(Continued on p. 284)

MICHIGAN DISTRICT'S LETTER BALLOT

By F. E. CHARLES [1]

ONE of the admirable features of soil conservation districts is that they are organized by land owners and managed by supervisors elected by residents. Framing of the district work program offers one of the first opportunities for the people to express themselves on operation of the district.

To make sure that residents of the district had a part in forming their work program, supervisors of the Fenton, Mich., district employed a unique idea. They gave to landowners this brief "letter ballot":

> The following is designed to determine what you think are important problems or activities that you and your community are or should be concerned with, or whether they could be used in your township for the betterment of the township. By placing check mark in front of items listed below that you feel are most important, you will enable us (the Directors of the Fenton Soil Conservation District) to get a summary of problems or activities that should receive special emphasis in our program. If there are other activities or problems that we have not listed, we would be pleased to have you write them in the spaces provided at the end of the list.

[1] Chief, regional division of information, Ohio Valley Region, Soil Conservation Service, Dayton, Ohio.

This introduction was followed by a list of 42 methods, practices, and services, arranged in ballot form, so that the landowner might express easily his interest and so that his suggestions could be considered for inclusion in the district work program. A place for the landowner to write his name and address completed the letter.

The Fenton district supervisors believe that this is a good method of obtaining widespread expression on the details of district operation. It is proving efficacious also in arousing interest in the work of the district, getting every landowner to thinking of the problems, and in giving everyone an opportunity to state his opinions. J. H. Skinner, employed in 1912 as Michigan's first county agricultural agent but now a farmer, originated the letter ballot for the Fenton district supervisors. The district, fourth to be established in Michigan, embraces parts of Livingston and Genesee Counties and includes a portion of the Fenton soil conservation demonstration area.

CONSERVING KEY AREAS IN SOUTHWESTERN RANGE LANDS

(Continued from p. 263)

with alfalfa. It is planned that, as rotations come into practice, several hundred acres will be in cereal crops each year. Also, about fifty acres of overflow lands having relatively poor drainage will be seeded to Reed's canary grass.

Considerable clearing of brush land has been done by the Indian Service. A bulldozer attachment was used for this work and this implement, in addition to removing the brush, also tills the land and thereby facilitates follow-up leveling for irrigation. A heavy brush railer, designed by the Indian Service with the assistance of the Soil Conservation Service technicians, cuts a 12-foot path and windrows the brush behind it. One man operating the tractor and railer can remove and windrow 15 to 20 acres of sagebrush a day. On moderate slopes, with limited irrigation facilities, the brush will be windrowed on the contour and used as protective buffers for new seedings. On other areas the cut brush will be scattered over the seeded areas as demonstrations of mulching for erosion prevention, for seedling protection and moisture conservation. According to present plans, several hundred acres of sage-covered bench lands will be cleared in this manner so that the land can be used for pasture or hay.

Grasses and legumes specified for pasture and hay are yellow sweetclover (*Melilotus officinalis*), western wheatgrass (*Agropyron smithii*), crested wheat (*Agropyron cristatum*), and giant wild rye (*Elymus condensatus*). On the more favorable sites, smooth brome (*Bromus inermis*), and mountain brome (*Bromus marginatus*) will be used in mixture with the above named species. Coincident with the seeding program, proper management practices will become effective.

The Duck Valley Indian Reservation is an example of numerous similar "key spots" that are to be found throughout the range country in the Pacific Southwest. The welfare of the people and of the land in these communities determines, to a large degree, the usefulness of the millions of acres of grazing land that surround them Meadow pasture values cannot be readily computed in dollars and cents when there are hungry animals and no hay stacks, and when Nevada lives up to its name as a snow-covered highland. By applying conservation principles to these "key spots," increased forage production can be expected and the tendency toward over-utilization of the range can be relieved without necessarily diminishing the number of livestock.

PRICE RIVER DISTRICT AND THE SUBMARGINAL LAND PROBLEM

By R. G. HOWARD [1]

A NEW idea for forestalling fruitless attempts to develop submarginal farms has been put to work in Carbon County, Utah. The plan is based on an agreement between the county commissioners and the Price River soil conservation district whereby the commissioners will sell county lands only after they have been carefully inspected and land-use capabilities determined. This makes it possible for both the county authorities and prospective purchasers to know what may ordinarily be expected of a piece of land on a long-time production basis.

Carbon County, as the name suggests, is highly productive of coal. Surface usage of timber, grazing, and irrigation farming are considered minor industries. In the depression years, around 1933, 75 percent of the privately owned farm land was forfeited to the county because of delinquent taxes. Since then many of the better lands have been redeemed, mostly by their former owners, but a large acreage is still held by the county. Some can be used profitably but the remainder never can be made into productive farm land.

The farming communities are located in areas of highly dispersed soils which erode rapidly at the slightest cause and are underlain by the Mancos shale beds at depths of a few inches to several feet. The shale is so highly impregnated with soluble salts that irrigations, where the shale beds lie close to the surface, quickly saturate with alkali both the shallow soils and any adjacent soils receiving that water as subsurface drainage.

Modernization in the mines through use of labor-saving machinery has caused a steady decrease in employment, and the miners, to whom the change in labor needs is constantly evident, are buying farms and moving to them. These underground workers usually think of the farms as double securities—homes from which they cannot be moved because of industrial inactivity, and productive outlets for labor during lay-off periods. Most of them have little knowledge of the requirements necessary to a profitable farm unit and they are often deceived by soil surface appearances. The result is that scores of miners have moved to farms that are submarginal in every sense of the word.

For the most part these farms have been purchased from the county because the land could be obtained more cheaply there than elsewhere. Purchases are made on a sale-contract basis with a small down payment and the balance prorated over a 2- or 3-year period. As an added incentive, no taxes are assessed until the contract is completed and title actually passed.

To the bona fide farmers and agricultural agencies, the consequences of this movement to "unfit lands" was very apparent and became the subject of comment in various farm group meetings. In an effort to work out a solution, the county extension agent, the Farm Security Administration supervisor, and the district conservationist of the Soil Conservation Service called a joint meeting of the county agricultural planning committee, the farm-debt adjustment committee and the Price River soil conservation district supervisors. At the meeting the facts of the problem were reviewed and suggestions were requested. Those attending the meeting included 13 of the key farmers and businessmen of the community.

Discussion revealed the fact that the Price River soil conservation district already had a memorandum of understanding with Carbon County providing for proper land use on county-owned lands, and that some technical help was available to the district through its memorandum of understanding with the Department of Agriculture. Accordingly it was unanimously decided that with these facilities as a foundation, remedial measures could best be carried forward by an amendment to the existent agreement between the district and the county.

These businessmen and farmers met with the county commissioners, reviewed the problem to them and explained its seriousness, and proposed that all applications for purchase of county-owned lands be referred to the district supervisors. Under such a plan it would be the duty of the Price River district to have a physical survey made of the lands applied for—the surveys to be turned over to an investigating committee of three representing the above-named farm groups. This committee of three would, in turn, review the physical survey data and, if necessary, actually go over the land to determine its potential utilization. They would then make a report of findings to the county commissioners. Finally, the commissioners would require as a consideration of sale that the land be used only to the extent of its capabilities as

[1] District conservationist, Fremont-Price area, Southwest Region, Soil Conservation Service, Price, Utah.

determined by the committee in its report, and that the land be placed under cooperative agreement between the purchaser and the soil conservation district.

After all phases of the proposal were carefully considered, an amendment calling for these provisions was prepared and signed. There was one exception, however, to the original recommendations: As a result of a legal opinion, the requirement for cooperative agreement was applied only to those lands where the prospective buyer offered a price less than the total tax obligation. The commissioners were confident that this would include 97 percent of the purchase applications.

In the first three weeks 20 different plots of land totaling 3,600 acres, on which more than 30 applications were filed, were referred to the district. Reports on 15 of these plots have been returned to the county commission. The committee, at its own request, does not know the names of applicants as they wish to form an unbiased opinion and to prevent situations which might result in criticism.

The committee's report on each piece of land consists of four parts as outlined below:

A. Physical survey map, colored to show land-use classes according to their capabilities.

B. Simple key from which the layman can interpret the physical survey data.

C. Copy of the general standards and capabilities of the various land classes.

D. Data sheet, giving the following information:

1. Number of acres.
2. Location of the land in reference to existent landmarks.
3. Amount of arable land by classes which can be irrigated.
4. Amount and location of alkali.
5. Amount and condition of fences.
6. Number and condition of other improvements.
7. Opinion of the investigating committee as to whether or not the farm can be made an economic unit.
8. Any additional comments by the committee. Such comment may be, in effect, that the land could be used by an adjacent operator but not as an economic unit in itself; or that the land could be used for grazing purposes in connection with an already established farm or range unit, but should not be sold to an outsider who could use it merely as a place to locate stock which would immediately trespass on established units.

The county authorities have long recognized that they were faced with two serious problems: First, that if the lands were to be permanently productive in tax payments, proper land use must be observed; and second, that misrepresentations by applicants frequently caused them to take less for land than they felt was justified after seeing its value in terms of production.

These authorities have expressed themselves as feeling that the data being furnished will aid them in solving both of these problems. The farm committees who were responsible for initiating the program are certain that it is a step forward in the development of a progressive and permanent farming community.

FIELD BOUNDARIES IN ENGLAND

(Continued from p. 281)

the life of that civilization? Today, after two and three thousand years of agriculture, fields are still highly productive; soils are protected from erosion wastage, and farms and equipment are maintained in orderliness for the future.

Field boundaries mark the limits of rights and type of land use; they set apart, as well, the areas of responsibilities. They avoid conflicting uses of land within an estate and within a nation. Over a multiplicity of division spreads a unity of purpose in a complexity of use. As the needs of man are various so is his use of the land. His requirements unify and coordinate the uses of land, as in selection and distribution of crops for fields and pastures. Varied uses of land are in time suited to the field in response to the requirements of a people and limitations of climate and erosion.

A SOCIOLOGICAL VIEW

(Continued from p. 277)

through carelessness and wasteful extravagance. Shall we see the time when bread made of wheat grown on our own land will be too dear for our children to eat? Little do we think so now, but little do we realize that the Balkan peasant once may have felt as we do. He had white bread, but now he must eat the black. It will be a sorry day for America when the farmers of this country become too poor to eat and to enjoy what they have produced by their own labor. Let it not come upon us.

IMPORTANCE OF SNOW SURVEYS

Snow surveys are designed to determine in advance what the water supply will be for the coming growing season. Irrigation farmers, power companies, cities, and other water users are notified of the results in order that the supply of water can be wisely rationed during summer months.

U. S. GOVERNMENT PRINTING OFFICE: 1940

Drainage and Irrigation Bulletins of Assistance to Conservationists

For REFERENCE
Compiled by Mrs. ETTA. G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS–37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information U. S. Department of Agriculture

The Border Method of Irrigation. Farmers' Bulletin No. 1243. Bureau of Agricultural Engineering.[1] Revised October 1937. 5c.[2]
Drainage in Arid Regions. Yearbook Sparate No. 1648, 1938 Yearbook of Agriculture. 1939.
Drainage in the Humid Regions. Yearbook Separate No. 1649, 1938 Yearbook of Agriculture. 1939.
The Drainage of Irrigated Farms. Farmers' Bulletin No. 805. Bureau of Agricultural Engineering.[1] Slightly revised December 1937.
Economical Use of Large Tile for Land Drainage. Technical Bulletin No. 269. Bureau of Agricultural Engineering.[1] November 1931. 5c.[2]
Erosion and Silting of Dredged Drainage Ditches. Technical Bulletin No. 184. Bureau of Public Roads. June 1930. 25c.[2]
Farm Drainage. Farmers' Bulletin No. 1606. Bureau of Agricultural Engineering.[1] October 1929.
Flow of Water in Irrigation and Similar Canals. Technical Bulletin No. 652. Bureau of Agricultural Engineering.[1] February 1939. 20c.[2]
Irrigation in the United States. Yearbook Separate No. 1646, 1938 Yearbook of Agriculture. 1939.
Orchard Irrigation. Farmers' Bulletin No. 1518. Bureau of Public Roads. February 1927. (Revised edition in process.) 5c.[2]
Policies Governing the Ownership of Return Waters from Irrigation. Technical Bulletin No. 439. Bureau of Agricultural Engineering.[1] October 1934. 5c.[2]
Practical Information for Beginners in Irrigation. Farmers' Bulletin No. 864. Bureau of Agricultural Engineering.[1] Revised June 1932. (Slightly revised edition in process.) 5c.[2]
Pumping from Wells for Irrigation. Farmers' Bulletin No. 1404. Bureau of Agricultural Engineering.[1] Revised May 1934.
Rainfall Intensity-Frequency Data. Miscellaneous Publication No. 204. Bureau of Agricultural Engineering.[1] August 1935. 10c.[2]
Reservoirs for Farm Use. Farmers' Bulletin No. 1703. Bureau of Agricultural Engineering [1] and Oregon Agricultural Experiment Station. June 1933.
Sewage Irrigation as Practiced in the Western States. Technical Bulletin No. 675. Bureau of Agricultural Engineering.[1] March 1939. 15c.[2]
Soil, Water Supply, and Soil Solution in Irrigation Agriculture. Yearbook Separate No. 1647, 1938 Yearbook of Agriculture. 1939.
Tests of Spray Irrigation Equipment. Circular No. 195. Bureau of Agricultural Engineering.[1] November 1931. 10c.[2]

Agricultural Experiment Stations

Construction of Small Dams for Farm and Community Use. Circular No. 154. North Dakota Agricultural College, Fargo, N. Dak. March 1937.
The Contour Check Method of Orchard Irrigation. Circular No. 73. California Agricultural Extension Service, Berkeley, Calif. March 1933.
Cost of Pumping for Irrigation in Colorado. Bulletin No. 387. Colorado Experiment Station, Fort Collins, Colo. March 1932.
Drainage of Land Overlying an Artesian Groundwater Reservoir. Bulletin No. 259. Agricultural Experiment Station, Logan, Utah. November 1935.
Drainage on the Farm. Circular No. 304. Agricultural Experiment Station, Berkeley, Calif. Revised June 1939.
Economic Benefits of Irrigation from the Kingsley (Keystone) Reservoir. Bulletin No. 311. Agricultural Experiment Station, Lincoln, Nebr. October 1937.
Effect of Irrigation and Cropping on Desert Soils. Bulletin No. 263 (Technical). Agricultural Experiment Station, State College, N. Mex. May 1939.
Equipping a Small Irrigation Pumping Plant. Bulletin No. 433. Colorado Experiment Station, Fort Collins, Colo. September 1936.
Essentials of Irrigation and Cultivation of Orchards. Circular No. 50. California Agricultural Extension Service, Berkeley, Calif. Revised September 1936.
Farm Drainage: Its maintenance and construction. Circular No. 493. Agricultural Experiment Station and Extension Service, Urbana, Ill. April 1939.
Farm Drainage Practice. Special Bulletin No. 149. Agricultural Experiment Station, University Farm, St. Paul, Minn. Revised October 1938.
Irrigation Development in Montana. Part 1. Water Supply. Bulletin No. 353. Agricultural Experiment Station, Bozeman, Mont. January 1938.
Irrigation of Orchards by Sprinkling. Bulletin No. 268. Agricultural Experiment Station, Pullman, Wash. August 1932.
Irrigation Pumping Plants. Circular No. 66. Agricultural Experiment Station, Moscow, Idaho. September 1931.
Irrigation Requirements of Cotton and Grain Sorghum in the Wichita Valley of Texas. Bulletin No. 543. Agricultural Experiment Station, College Station, Tex. August 1937.
Measuring Water for Irrigation. Bulletin No. 588. Agricultural Experiment Station, Berkeley, Calif. March 1935.
Orchard Drainage in the Medford Area, Jackson County, Oregon. Station Circular No. 100. Agricultural Experiment Station, Corvallis, Oreg. January 1931.
The Parshall Measuring Flume. Bulletin No. 423. Colorado Experiment Station, Fort Collins, Colo. March 1936.
Problems of Water Resources for Rice Irrigation. Bulletin No. 371. Agricultural Experiment Station, Fayetteville, Ark. February 1939.
Pump Irrigation at the North Platte Experimental Substation. Bulletin No. 301. Agricultural Experiment Station, Lincoln, Nebr. June 1936.
Rainfall and Discharge Records for Northern Iowa Drainage Districts. Bulletin No. 141. Iowa Engineering Experiment Station, Ames, Iowa. May 1939.
Subirrigation. Bulletin No. 99. Agricultural Extension Service, Gainesville, Fla. June 1938.
The Value of Irrigated Pastures for Dairy Cattle. Station Bulletin No. 366. Agricultural Experiment Station, Corvallis, Oreg. September 1939.

Miscellaneous

Agricultural Engineering: A Selected Bibliography. Bureau of Agricultural Engineering,[1] U. S. Department of Agriculture. 1937. mm.
Bibliography on Land Drainage. Bureau of Agricultural Engineering,[1] U. S. Department of Agriculture. 1936. mm.
Farmers' Irrigation Guide. Conservation Bulletin No. 2. Bureau of Reclamation, U. S. Department of the Interior. 1939.
Low Dams: A Manual of Design for Small Water Storage Projects. Water Resources Committee of the National Resources Committee, Washington, D. C. 1938. $1.25.[2]
Manual for Soil Erosion Control in the Tennessee Valley: Engineering Phase. Tennessee Valley Authority, Knoxville, Tenn. Revised October 15, 1939.

---

[1] The Divisions of Drainage and Irrigation of that bureau were transferred to the Soil Conservation Service effective as of July 1, 1939.
[2] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Tung seedling

MODERN methods of soil conservation and orchard management are vital to the young tung oil industry of the South. Field observations on the planning, planting and culture of tung orchards are made by George N. Sparrow, who contributes an article to this issue of SOIL CONSERVATION.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

JUNE
1940

Contents

Front and back covers by Adrian Clem

Center spread by Helen Morley

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.50 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

VOL. V • NO. 12 ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON JUNE • 1940

ECONOMIC AND SOCIAL CONSIDERATIONS IN FARM PLANNING

By E. H. REED [1]

THE program of the Soil Conservation Service is carried out primarily through complete coordinated plans formulated for individual farms or land units. If these farm or land unit plans are to achieve the purpose of the Service—"to bring about better land use, a better life for people living on the land, and protection of public welfare"—it is evident that they must provide for the most efficient utilization of all resources of the farmer, including the land.

Many ardent advocates of conservation seem to lose sight of the human element, which is so essential in real conservation, and to stress the physical aspects of the conservation problem—in other words to talk of erosion control practices as ends within themselves. There is but little virtue in conserving a tree for the sake of the tree or a hillside merely for the sake of the hillside. As expressed by Secretary Wallace: "Damage to the land is important only because it damages the lives of people and threatens their general welfare. The whole purpose of conservation goes back to that fact. Saving soil and forests and water is not an end in itself; it is only a means to the end of better living and greater security for men and women."

Too frequently people look upon a conservation program as one that holds resources out of use. In its simplest terms, conservation means *use without waste*. It is evident that in assisting farmers in planning farms the job of the Service is much broader than putting land in cold storage for the use of future generations. The real task is to put into effect a plan which over a period of years will best utilize the resources at hand. The farmer is not obtaining the most efficient utilization of his resources if his most important resource, the land, is being rapidly depleted by erosion as a result of improper land use or cropping practices.

Farming is a business upon which the farmer is dependent for his livelihood. The farmer is interested in erosion control practices only insofar as they may help him to conserve his capital and utilize his resources more effectively. Much of the reluctance with which farmers have accepted and applied soil conservation practices has been due to the fact that we have planned farms *for* farmers rather than *with* them, and have talked erosion control practices as ends within themselves rather than means of enabling the farmer to utilize his land, labor and operating capital more efficiently and at the same time conserve the productive capacity of his soil. Therefore, in planning farms with farmers it is important that erosion control practices and land use be considered in the light of the best combination of enterprises required to afford the best utilization of the resources of the farm and farmer.

Erosion control is achieved through a combination of proper land use and proper practices. Neither proper land use nor desirable practices can be determined on the basis of physical data alone but must be determined through a consideration of physical capabilities plus economic factors. Land-use capability classes do not determine land use but merely portray the capabilities of the land. The managerial

[1] Head, farm management section, division of farm planning and management, Soil Conservation Service, Washington, D. C.

229260—40——1

Recommendations for Land Use, Cropping Systems and Supporting Practices for Land-Use Capability Classes

Land-use capability class	Land Use	Cropping systems	Supporting conservation practices	Soil treat-ments
I (Green)	Cultivation	Row crop 2 years, small grain, hay	None	Manure
II (Yellow)	Cultivation	Row crop, small grain, hay	Contour strips, 75'-125', or terraces	Lime Manure
		Row crop, small grain, hay 3 years	Contour cultivation	Lime Manure
		Row crop, small grain, hay 4 years	None	Lime Manure
	Pasture	None	None	Lime Manure
III (Red)	Cultivation	Row crop, small grain, hay	Contour strips and terraces	Lim Ma
		Row crop, small grain, hay 2 years	Contour strips 60' - 100'	
		Row crop, small grain, hay 4 years	Contour cult	
	Pasture	None		
IV (Blue)	Pasture	None		
	Woodland			

ability and likes and dislikes of the farmer, his available labor and operating capital such as machinery and livestock, must be considered in relation to the capabilities of the land.

A number of methods might be used in controlling erosion on a given sloping field. For example, it might be devoted (*a*) to pasture, (*b*) to meadow, (*c*) to a long rotation with several years of hay, (*d*) to a rotation of medium length with contour cultivation and buffer strips, or (*e*) to a short rotation with terracing and strip cropping. Any one of these uses might satisfactorily conserve the productive capacity of the field. The use to which a particular field should be put will depend primarily upon economic factors. If the farmer needs pasture, and other fields on the farm are better suited for clean-tilled crops, he should probably put this field to pasture. If, on the other hand, he cannot utilize the pasture, he might terrace and strip crop it and use a short rotation. Economic factors should thus be considered in selecting the land use, the rotations and the practices which he should use.

Alternative combinations of land use and practices are not inconsistent with the definition of land-use capability classes. Land-use capability classes indicate the most intensive use of land and the least intensive conservation practices consistent with permanent maintenance of the soil. They are based largely on physical characteristics. It is not inconsistent to use class II land for class IV purposes if such use will better fit the needs of the farmer. As shown in the accompanying table there are several alternatives of land use, rotations, and supporting practices under each capability class. For example, class II land might be used in a 3-year rotation if strip cropped or terraced, or could be used in a 6-year rotation with 4 years of hay without supporting practices.

Many planning technicians realize that economic factors should be considered in planning, but they are at a loss to know what information is needed or how best to consider this along with physical information. It is therefore important that further attention be given this subject. No rule-of-thumb guide can be given that is applicable under all conditions, since each farm is an individual problem. However, certain steps, as outlined below, have been proved by experience to be desirable.

Inventory

An inventory of both the physical and economic conditions on the farm is necessary. The *physical inventory* consists of a determination of soil type, slope and erosion of the various fields on the farm. In order to make this information fully intelligible and useful, these factors should be expressed in land-use capabilities.

The *economic inventory* should consist of a record of the present organization of the farm such as acreage, production, and utilization of the various crops grown on the farm, together with the kinds and numbers of livestock produced. The approximate amount of labor and operating capital available for the operation of the farm should also be obtained. If the farmer is cooperating with the A. A. A., information should be obtained relative to the acreage allotment of the various crops. Insofar as practicable, these acreages should then be provided for in the farm plan. Under some conditions, additional information may be desirable; for example, the ownership or tenure status, the amount, source, and cost of irrigation water or other information of like nature that should be considered in the formulation of the new plan for the farm.

While obtaining this information from the farmer, the farm planner should obtain a concept relative to the farmer's knowledge of and interest in conservation; his knowledge of the principles that determine land use, and his knowledge of the applicability of various erosion control practices. The farmer's managerial ability and his knowledge of various enterprises, together with his likes and dislikes, should be considered

It would also be well to obtain, without making any commitments; the farmer's opinion as to the desirable changes which should be made in the farm organization in light of erosion control.

Determination of Alternatives

After the farm planner has obtained a clear-cut inventory of both physical and economic conditions, he should then determine in the light of this information the various alternatives in organization of the farm or combinations of enterprises which might be used in the best utilization of the resources of the farm and the farmer. It should be understood that "best utilization" includes conservation. It should be kept in mind likewise that resources of the farm and farmer include labor, operating capital, managerial ability and likes and dislikes of the farmer, as well as his land.

If it is apparent, on the basis of information obtained from the physical inventory, that comparatively little change is needed in land use, and that the major changes required would be the institution of erosion control practices such as terracing and strip cropping, the problem of organization may be comparatively simple. Even under this condition, however, careful study should be given to determine what if any effect the institution of such erosion control practices will have on the present organization or operation of the farm. For instance, one of the desired practices might be a change in rotation with a decrease in the acreage devoted annually to clean-tilled crops, and an increase in close-growing crops. If this were a livestock farm, such a change in the rotation would probably throw the feeds for livestock off balance. If little or no livestock is kept and the crops are marketed directly as cash crops, the question then arises as to the market outlets for these close-growing crops and the possibilities of income under the proposed plan as compared with the original plan.

In case it is apparent on the basis of physical information that considerable changes are needed in land use as well as practices, the farm planner should select a combination of land use and practices that would be satisfactory from the standpoint of soil conservation. He should then calculate the physical quantities of products which, on the basis of expected yields for the farm would be available under this assumed organization and combination of enterprises. For example: What quantity and kinds of cash crops would be available for sale? How much feed would be available for livestock? Are the various kinds of feed (grain, hay, and pasture) in proper proportion to livestock feed needs? Under this organization, will the farmer be able to keep more or less livestock than formerly? What effect would such an organization have on the labor or operating capital requirements? Can the farmer meet these requirements?

The farm planner should then select another combination of land use and practices, in order to test the desirability of the second alternative as compared with the first. The same process of thinking and calculation as suggested above should be pursued in each new combination.

In complicated or difficult situations, or until the farm planner obtains considerable skill in selecting alternatives, it may be necessary to assume a third, fourth, or even fifth alternative and calculate the probable results as outlined above so that he may be able to discuss intelligently with the farmer the relative desirability of the several alternatives. The farm planner in some instances may desire to do this figuring in the presence of and in consultation with the farmer; often, however, he may prefer to make these calculations in the office and use them for discussion with the farmer at a later date. If the farmer has attended a number of group planning meetings he may be able to suggest the various alternatives for consideration with the farm planner.

Selection of the "Best" Alternatives

After these several alternatives have been considered by the planning technician, he is then in position to consider them in cooperation with the farmer and to select, after thorough discussion with the farmer, the alternative which in their combined judgment will best conserve the physical resources of the farm and at the same time provide for the most efficient utilization of the resources of the farm and the farmer. Through a discussion of the advantages and disadvantages of the various alternatives, the farmer should understand why the selected alternative is "best" and what if any adjustments will be required in his present system of farming or practices. For example, in order to utilize efficiently any additional hay, is it desirable to increase roughage-consuming livestock or shift from cash crops to a combination of cash crops and livestock? Does he need to change his feeding practices? Does he have sufficient barn room to house the additional livestock? If this process of thinking

(Continued on p. 300)

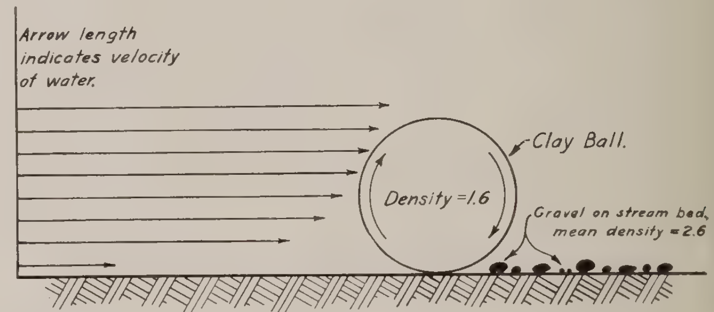
THE "WHEELS" OF EROSION

By HUGH STEVENS BELL [1]

IN the January 1940 issue of SOIL CONSERVATION Dr. Mark L. Nichols states that the whole field of the hydraulics of erosion is practically untouched and lists many of the unexplored problems involved. Among these he mentions the transportation of erosional debris as bedload. Field and laboratory studies of one of the most efficient methods of bedload movement were completed recently at the Cooperative Laboratory of the Soil Conservation Service and California Institute of Technology at Pasadena, Calif. These particular studies developed as a byproduct of assistance given to technicians of the Las Posas project at Santa Paula, Calif., during an investigation of gully development which was in progress at the time of the spectacular storm of February 27–March 2, 1938. A more detailed and technical discussion of the material presented in the present paper has been published in the Journal of Geology.[2]

More than a quarter of a century ago G. K. Gilbert [3] pointed out that particles are transported by a stream in four ways, depending on their size, shape, and density. They may slide, leap, roll, or be carried in complete suspension. Only the first three of these methods are available for the movement of bedload, and they are listed in the ascending order of their efficiency. In other words, a bedload particle that is round enough to roll will travel more swiftly than those of equal weight and density that are forced by their shapes to slide or leap.

It is widely recognized that the wheel is man's greatest invention, but it is practically unknown that Nature sometimes uses wheels to roll erosional debris away, and thus greatly accelerates the cutting of gullies in areas where clay is abundant. Balls of clay or mud are just such wheels, and many streams are able to produce them rapidly in enormous numbers during times of flood. The accompanying photographs show some scattered over the surface, and others forming an important part of the bed deposits about a mile downstream from the mouth of a gully in Ventura County, Calif.



Why a clay ball is transported more rapidly than the smaller units of a bedload. Increased efficiency results from a combination of high velocity, low density, and great sphericity. Invariably, such balls are large in comparison with the particles which form the stable bed of the stream in which they are formed.

Ordinarily such balls are looked upon as mere curiosities—freaks of nature. Actually they are among the most efficient and effective devices to be found in the entire erosion set-up. A rough, angular block of clay caves from the bank or is torn from the bottom of a stream. If it is not too large it is immediately swept along by the flood and its numerous sharp angles are rapidly abraded or molded into roundness. If it strikes some fixed object squarely it may be broken into many pieces, but the individual fragments often are rounded into shape quickly by continued tumbling and pounding.

Within as little as 10 minutes the original irregular block may become one or many clay cobbles or boulders which leap from the bottom with decreasing frequency as they become increasingly spherical. Pebbles, shells, bits of broken glass, rusty nails—hard and heavy objects of every description—adhere to the sticky, softening clay mass, and are driven more deeply into its plastic outer layer with every revolution, every leap of the rapidly forming ball.

Such heavy particles are the very ones which a stream must depend upon to stabilize its bed, but the clay balls may actually remove them so thoroughly from the bottom that the rushing waters cut rapidly into the underlying softer materials.

An hour after a clay chunk starts its journey it may have become as round as a ball, and have traveled 3 miles, meanwhile collecting nearly 50 percent of its original weight in gravel and other foreign material as it rolled. All this may have happened, and the ball is

[1] Associate soil conservationist, sedimentation division, Soil Conservation Service Pasadena, Calif.

[2] Armored Mud Balls—Their Origin, Properties, and Role in Sedimentation. By Hugh Stevens Bell. Journal of Geology, Jan.–Feb. 1940, pp. 1–32.

[3] The Transportation of Debris by Running Water. By G. K. Gilbert. U. S. Geological Survey Prof. Paper 86, 1914, p. 200.

deposited in a permanent resting place before it has been wet to a depth of more than an inch. Estimates, which are thought to be conservative, show how important this method of bedload movement sometimes becomes, for they indicate that approximately 500 tons of clay and over 200 tons of gravel were removed from one Ventura County gully in this way during a single flood. A more striking example occurred some 20 years ago, when Corn Creek, a tributary of the Little Colorado River, built a dam of mud balls across the main stream and forced it to abandon a section of its channel permanently.

The size of the pebbles which may be transported by mud balls is directly proportional to that of the balls themselves. Stream-made balls commonly vary in size from slightly less than 1 inch to about 1 foot in diameter, while the maximum size of the particles they carry ranges from that of peas to that of hen's eggs.

A clay ball may have a density of 1.6 and the pebbles on the streambed a mean density of 2.6. Since a stream can transport spherical masses of a light material more readily than it can the irregular fragments of a much denser substance, it is obvious that any pebble which becomes attached to a mud ball can be more easily moved by the stream because it has, in effect, decreased its density by becoming a part of a less dense whole. Since the clay mass is comparatively large the pebble greatly increases its effective size and, in all probability, its effective sphericity as well.

Each of these changes makes it possible for the stream to transport the pebble more swiftly and more easily. Being effectively lighter and rounder it not only can be rolled with comparative ease, but also its greatly increased effective size subjects it to much higher velocities, as the diagram indicates. This is of great importance, because the weight of a particle which may be moved increases as some power of the velocity. If the widely discussed sixth power law is valid, then an increase in velocity of 2, 3, or 4 times allows the weight of the particle that can be transported to be increased correspondingly 64-, 729-, or 4,096-fold. Thus it is seen that with the aid of mud balls a stream is able to put its higher velocities to work and, with both efficiency and power greatly increased, move enormous quantities of those smaller, denser particles that ordinarily remain to hinder erosive processes.

It is no longer possible to look upon mud balls merely as interesting curiosities. Surely any device which makes it possible for a comparatively small quantity of

Hundreds of mud balls abandoned by the receding waters of a California flood are shown in the photograph above. The picture below was taken about five months later at the same location. It shows that the balls were present in great numbers beneath the surface, where they played the role of ordinary cobbles and boulders in the channel deposits.

water to move a million pounds of clay and 200 tons of gravel from one gully during a single flood, and transport that material with efficient dispatch to a point miles away, ceases to be only an object for the amusement of the curious.

Long after ordinary bedload particles have ceased to move and the heavier units of the suspended load have been dropped by the stream, the mud balls roll persistently onward, gathering and carrying with minimum effort a burden of those pebbles which, because of their irregular shapes and greater densities, soon would have been abandoned by the stream or perhaps never moved at all. Though the waters of the gully debouch upon an alluvial fan and spread wide in a dozen distributaries, still these wheels of erosion move quite steadily forward and, if the bed be smooth and firm, refuse to stop even when the water is no longer deep enough to cover them completely. When at last

(Continued on p. 308)

THE ROLE OF NEEDLE-AND-THREAD GRASS IN THE GREAT PLAINS

By B. W. ALLRED [1]

THE purpose of this article is neither to minimize the vices of needle-and-thread grass (*Stipa comata*)—hereafter referred to as needlegrass—nor to proclaim its virtues. It is to give instead a general picture of its ecological position and economic significance on the range lands of the Great Plains.

Probably no other grass in the Great Plains is in such bad repute as needlegrass. Resentment is keenest during the fruiting season when the sharp barbs of the fruit, commonly called the seed, spear anything coming in contact with them. Where dense stands occur, they are nearly as formidable at seeding time as a cactus bower. Fortunately, the seed-maturing period lasts only 2 or 3 weeks during early summer; after this the seeds drop to the ground where they remain, quite inoffensive. The plant is generally condemned by stockmen, but sheepmen have the most serious case against it. The seeds with their long awns make a fleece look like a pincushion and the sharp barbs often pierce the eyes of sheep and blind them. The barbs also work through the wool into the skin, starting irritations that sometimes cause a sheep to shed its fleece.

Accurate statistics on actual damages resulting from this plant are lacking, but my experience with sheep in southern Colorado and Wyoming does not bear out some apparently exaggerated claims of heavy sheep losses. I have never seen more than 12 sheep among bands of 1,000 head that suffered blindness or broken fleeces from the ill effects of the grass. It is claimed by some sheepmen, however, that buyers impose rigid cuts against lambs suffering injuries from needlegrass. The barbs may also cause distress to grazing animals even when no economical loss is apparent. In certain localities stockmen have been induced to start work to obliterate needlegrass, but such a task, if carried through, would bankrupt the monetary resources of the Plains without accomplishing its purpose.

The acute interest in needlegrass has prompted many inquiries as to the origin of the species. Many believe that it is an immigrant from another region that has become naturalized here since the great drought of 1934. One of my purposes in writing this article is to attempt to show that needlegrass is a true native of the Great Plains. This grass has one of the most clean-cut genealogies known to plant science, and fossil specimens show that it has inhabited the Great Plains since the Tertiary (Oligocene) geological epoch, which by some geologists is dated back about 35 million years. The study of ancient specimens has thrown considerable light on the vegetation, climate, and habitat of that epoch. Photographs of age-old needlegrass (*Stipa kansasensis*), made by Maxim K. Elias, paleobotanist at the University of Nebraska, in 1931, indicate a striking similarity to the present needlegrass of out Great Plains. Elias and others found, in the deposits with the ancient needlegrass, other plant associates such as hackberry (*Celtis willistonii*) and stickseed (*Krynitzkia coroniformis*). Likewise, these fossils show a remarkable resemblance to the common hackberry (*Celtis communis*) and stickseed (*Krynitzkia* sp.) of the Great Plains. These studies have given background for the belief that the climate of that remote age was semiarid, though probably less so than now.

Needle-and-thread grass (**Stipa comata**) *in its native habitat northwest of Rosebud, S. Dak.*

Elias (1935) states that these plant remains were collected also in the unsorted continental deposits of early Pliocene age where they were associated with the fossil bones of *Pliohippus leidianus*, the Pliocene ancestor of our modern horse. It is believed that the Pliocene geological formation represented the flood plain habitat of the Rocky Mountains piedmont. The undisturbed condition of the plants indicates that they were buried close to their place of growth.

Clements (1936) states: "It is probable that the evolution of grassland proceeded more rapidly in the

[1] Chief, range conservation division, Northern Great Plains Region, Soil Conservation Service, Lincoln, Nebr.

period of mountain-making in the Upper Oligocene to produce the forerunner of the modern prairie in the Miocene, where the typical genus Stipa is recorded, along with horses of the grazing type, *Merrychippus* and *Protohippus*."

The study of paleobotany has established the residential status of needlegrass so far as antiquity is concerned, and ecologists such as Pound and Clements (1898), Weaver and Clements (1929), Hanson and Whitman (1938), and Shantz (1938) have recognized it as a climatic dominant over wide areas of the Great Plains. Range forage investigations made by the Soil Conservation Service, since 1935, show its presence in the semiarid range lands of Montana, the Dakotas, Wyoming, and Nebraska. They have reported it to a more limited extent in eastern Colorado, and more prominently again along the Rocky Mountain front in Colorado to as far south as central New Mexico. It is known to extend throughout the semiarid plains of Canada to the hardwood forest belt in the north.

It is rarely found in pure stands in large areas, although it is not uncommon to find small communities of it comparatively free from other associates. It is most commonly found growing with blue grama (*Bouteloua gracilis*), nigger wool (*Carex filifolia*), and western wheatgrass (*Agropyron smithii*). During years of abundant spring rainfall it dominates the scene, for it is of northern derivation and springs forth early to mature and disseminate its seed before midsummer, ahead of the customary dry summer weather. In the seasons when spring rains are deficient and summer rains of greater abundance, the needlegrass is superseded in prominence by later growing grasses such as blue grama. This situation no doubt accounts for the opinion held by some that the plant was nonexistent on the Plains during the drought but appeared as if by magic once the drought subsided and spring rains reoccurred.

When considered as a forage for livestock, needlegrass ranks about 25 percent below blue grama, nigger wool, and western wheatgrass. Were it not for its pernicious seeding habit it would be rated very favorably by stockmen. In any event, it plays a significant role in the economy of the range land. Because of its early spring growth habits, like that of prairie junegrass, western wheatgrass, and nigger wool, also of northern origin, it furnishes timely early green feed to lambing ewes and calving cows in need of succulent grazing for milk production. The grass is relished by livestock until the time of seed maturity, after which it is rejected for the tender summer-growing grasses such as blue grama and buffalo grass (*Buchloë dactyloides*). During years of late rainy autumns, needlegrass greens up and remains so until snow falls. Its dry leaves and stalks are a desirable source of winter feed for cattle and sheep, particularly during times of deep snowfall when the short grama and buffalo grasses are covered. Native hay produced from it compares favorably with western wheatgrass hay as a maintenance ration, if it is cut when the seed is in the early dough stage. If allowed to mature before cutting, the hay will be full of barbed seeds and unsuitable for feeding purposes.

When it is in its undisturbed natural habitat, needlegrass usually prefers the better drained medium-textured or gravelly outwashed soils. It tends to give ground to western wheatgrass in the better-watered lowlands and swales. It gives way in the same manner to the short grasses on the more arid upland sites, and in turn during the dry years it moves into the draws and swales with western wheatgrass and in wetter years invades the short grasses in the more arid spots. However, it is equipped to perform the functions of a "crisis" plant and can readily take over disturbed areas of either sands or heavy clays, unless kept down by excessive alkali or active blow dirt. It can perform this role quickly as it has special equipment for migrating into barren areas and populating them until other less mobile species can follow. By means of a barbed seed shaft, it attaches itself to livestock, rodent, or man, and is carried to new areas. It has an adaptive device known as a hygroscopic awn, a threadlike appendage attached to the seed that draws up like the spring on a clothespin during dry weather and uncurls during wet weather. When the awn is coiled, a stiff wind can blow the seed for short distances. After the sharp barb settles on the ground it works into the soil by means of the movement of the awn, very much as does a porcupine quill into living flesh. As the barbed seed works into the moistened topsoil, it softens and the seed goes to rest in a soil medium suitable for late fall or early spring germination. The ingenious seeding devices just described give needlegrass a decided advantage over most other plants in invading and establishing itself on new sites.

This grass is not being used by the various Federal agencies in their reseeding programs because of its barbed seed; efforts to find a practical way of detaching the awns so that the seed can be seeded through drills have been unsuccessful. The awns likewise make

hand seeding impracticable. However, there is no need to seed this grass artificially for the purpose of regenerating abandoned farm lands or depleted range lands, because western wheatgrass takes over abandoned land as easily or more easily than needlegrass. Wheatgrass can be sown through a drill; it yields more seed; it has a little higher feed value and has none of the undesirable qualities of needlegrass. Crested wheatgrass (*Agropyron cristatum*), western wheatgrass and grasses not native to the Plains can be used in place of needlegrass for artificial reseeding on abandoned farm lands and are in fact superior to needlegrass.

Needlegrass is found most abundantly on well-managed range lands or on areas long under protection from livestock, and sometimes on abandoned lands returning naturally to perennial vegetation. This is further borne out in studies by the Soil Conservation Service on Indian Reservations in the Plains, relict areas in South Dakota, and protected ranges in Montana, Wyoming, and North Dakota.

Like other mid grasses (or tall grasses), needlegrass is handicapped by unrestricted grazing, to the benefit of such shorter species as grama, nigger wool, and buffalo grass. Continued close cropping of needlegrass by livestock during its growing season reduces the green leaf and stem surface needed to build up the essential food reserves. Successive abuses of this kind are responsible for depletion of many of the forage plants on the range. The reduction of needlegrass in the Great Plains has been verified by Weaver and Clements (1929) and by Sarvis (1923), who found that the plant lost dominance as a result of heavy grazing in dry years. It is further borne out by the studies of the Soil Conservation Service on relict areas in South Dakota and the golf course at Rapid City, S. Dak., as well as on comparative study on used and unused range land near Baker, Mont.

The fact that moderate use to overuse of range lands brings a reduction in needlegrass in the Great Plains will invoke no lament from stockmen. But it is significant to know that when this grass is removed by overuse, on ranges where it is a natural member of the original plant association, the forage resource is probably reaching the critical point from which deterioration may quickly set in. On these ranges needlegrass can be used as a delicate barometer, as its recession is the first indicator of range deterioration. The next stage of recession will be noted by the presence of indicator plants of poor feed value such as snakeweed (*Gutierrezia sarothrae*), silver sage (*Artemisia frigida*), sagebrush (*Artemisia tridentata* and *A. cana*), and perennial aster (*Aster multiflorus*), in the earlier stages of deterioration; and such plants as annual sunflowers (*Helianthus annuus* and *H. petiolaris*), Russian thistle (*Salsola pestifer*), pigweed (*Amaranthus retroflexus*), gumweed (*Grindelia squarrosa*) and many others in the later stages. These plants have low feed value and produce inferior parts for the purpose of soil protection.

Needlegrass has inhabited the plains for geologic ages and even though it has undesirable qualities during its seeding season, a better understanding of its habits and qualities will facilitate dealing with it and may in some instances actually point the way to advantageous use of the plant. Needlegrass is pestiferous to all stock during its seeding period and is particularly irritating to sheep. However, the task of lessening the livestock losses from this source may not be so difficult as is presumed. The only sheep that need be subjected to it are those that summer in the plains.

There are millions of acres of abandoned farm lands in the Great Plains, yielding nothing but annual weeds, which could be converted to perennial grasslands to supply feed during critical periods. These areas might well be seeded to grass both to provide pasture for use when needlegrass is bothersome on the native range, and to provide early spring and late fall grazing.

REFERENCES

F. E. Clements: The Origin of the Desert Climax and Climate. 1936.

Maxim K. Elias: The Geology of Wallace, Kansas. 1931.

Maxim K. Elias: Grasses and Other Plants From the Tertiary Rocks of Kansas and Colorado. 1932.

Hanson and Whitman: Major Grassland Types of Western North Dakota. 1938.

R. Pound and F. E. Clements: The Phytogeography of Nebraska. 1898.

J. T. Sarvis: Effects of Different Systems and Intensities of Grazing upon the Native Vegetation at the Northern Great Plains Field Station. 1923.

H. L. Shantz: Plants as Soil Indicators, included in Soils and Men, U. S. Department of Agriculture Yearbook. 1938.

J. E. Weaver and F. E. Clements: Plant Ecology. 1929.

IMPROVED TILLAGE AND RESIDUE MANAGEMENT PRACTICES IN REGION 9

By SAM L. SLOAN [1]

ONE of the first recommendations of the Soil Conservation Service in Region 9 (Washington, Oregon, and Idaho), when an operations program was undertaken, was that the burning of stubble be stopped and all crop residues be utilized for erosion control. The practices involved in this recommendation have more significance and are more effective in the control of erosion on farmlands in these three States than in many other general farming areas.

In the first place, most of the agricultural land in the Wheat Belt is farmed in large units under a one-crop, alternate fallow-and-wheat system necessitating heavy machinery. This situation limits the scope of practices that may be applied in a diversified farming system with smaller farms and smaller equipment; it also gives greater significance to those practices that are applicable and effective without the introduction of major adjustments.

Secondly, because of the winter type of rainfall common to the region the heaviest soil and moisture losses occur in late winter and early spring. The limited cover afforded by fall-sown grain constitutes another factor necessitating greatest possible use of crop residues in such a way that they are effective not only during the summer fallow season but also through the critical erosion period in the spring. Fortunately, crop residues are abundant over most of the wheat-growing area; thus it is possible, with proper management, to limit soil and moisture losses from cultivated lands by using a combination of tillage practices.

We can better appreciate the importance of the problem when we consider that it has been common practice over much of the wheat-growing area of the region, since wheat growing was started, to burn part or all of the stubble. If any remained it was turned down completely in the first tillage operation. A radical change from this custom is observed, however, in the adoption and application of a series of delicately adjusted operations providing for conservation and use of residues in quantity sufficient for erosion control.

Data from evaluation studies conducted at the Wildhorse project in eastern Oregon, during 1937 and 1938, show that about 300 pounds of straw per acre, left on the surface at fall seeding time, serves to reduce soil and water loss effectively; and that an adequate mulch of stubble on the surface in combination with contour seeding, provides a high degree of erosion control in normal years. Data from evaluation studies in the Palouse indicate that to control erosion at least 500 pounds of straw, or more, depending on slope gradient, must be left on the surface in the fall. A research program has been initiated, in cooperation with State agencies in both Idaho and Washington, to obtain reliable data on the role of crop residues under a variety of systems of management, in the control of erosion and interrelated effects on crop yields, soil moisture, available nitrogen, soil temperature, soil structure, etc.

The use of crop residues for wind-erosion control is an established practice in many communities throughout the region. Abandonment of large areas has been forestalled and other areas actually have been reclaimed by careful husbanding of all residues and by fallow operations conducted in such a manner as to obtain maximum protection against the destructive forces of wind erosion.

Three distinct conditions are encountered in various sections of the region. The first is found in the area where annual cropping is practiced (e. g., wheat and peas), with large yields of grain the rule and correspondingly heavy crop residues. Another condition exists in the better wheat-growing sections of the summer fallow area where precipitation is insufficient for annual cropping but is more than the minimum required for dry farming. These sections produce uniformly high yields, with heavy crop residues. The third condition is that found in areas of low rainfall where the precipitation is slightly above the absolute minimum for wheat growing, and here are moderate to low yields and light crop residues. Seasonal variations within any of these areas influence the amount of crop residues to be dealt with and determine the type and number of operations required to utilize the crop residues properly.

The first problem was to overcome the objections, the difficulties, and the negative attitude of cooperators in handling crop residues according to recommendations. This involved determining for each situation

[1] Chief, regional agronomy division, Pacific Northwest Region, Soil Conservation Service, Spokane, Wash.

229260—40——2

A satisfactory job of residue management. End of fallow period shows straw and clods on the surface, lower portion of tilled zone compacted. The seedbed is in good condition for fall wheat.

the type of implement best suited to the work, or the modification that could be made in available implements to accomplish desired results.

Early crop-residue management practices stressed mixing the residues with the furrow slice. Although this practice is not objectionable under certain conditions of rainfall and a high level of available nitrogen, a lack of this balanced soil condition is almost certain to result in lower yields than if the stubble were burned or turned down with a moldboard plow.

Observations and limited experimental data have revealed that increased protection from erosion is obtained, and that there is less effect on crop yield through disturbance of the carbon-nitrogen ratio, when the crop residues are placed largely on the surface instead of being mixed with the soil. Because of this, efforts in the residue management program have been directed toward the maintenance of a "straw mulch" on the surface rather than toward a stressing of the "trashy fallow" method.

Notable results have been obtained in standardization of the technique of management and in bringing about an appreciation of the importance of proper residue management on the part of cooperators and farm leaders throughout the wheat-growing area of the region. The principles involved in proper residue management must be understood by the operator, as the specific operations, their number and sequence, are determined by the amount of residue available for utilization, and its condition especially at the time of the first field operation. One of the first of these principles to have wide application in the region is that embodying the idea that more effective erosion control is obtained after the fallow period by leaving stubble undisturbed in the fall than by fall tillage.

In the management of very heavy crop residues, especially in preparation for a spring crop, it is necessary to perform one operation in the fall with the disk or one-way to induce partial decomposition and to reduce the amount of residue to a point permitting satisfactory handling in future operations. In other areas that receive heavy snow, particularly where heavy soils or tight subsoils are found, and in areas subject to rapid snow melt and run-off when the ground is frozen, fall chiseling on the contour is necessary.

The most commonly recommended procedure, however, is that stubble be left standing over winter. Use of a modified moldboard plow, lister bottom, or one-way is followed promptly by the rotary rod weeder to compact the lower portion of the disturbed area to prevent evaporation. Necessary rod weeding operations follow as required for weed control. The modified moldboard plow or lister bottom is used for the plowing operation because with this type of implement the soil is loosened from below with a minimum of turning action and the crop residues are left mostly on the surface. A point in favor of these implements, and one that has influenced their acceptance,

is that they till the soil to the normal depth and leave the straw on the surface. Substantially the same results can be obtained with the one-way if it is run at the proper speed; the speed determines to a large degree the amount of coverage of the residues. The one-way also is successful in excessively trashy and weedy fields where other types of implements will not handle the residues. Regardless of the care exercised in using this implement, however, it does have a pulverizing action that destroys the structure of the soil in most soil types.

The change from black fallow to complete or even partial stubble utilization necessitates a change in the type of drilling equipment. Although the double disk drill is used extensively, the single disk drill is most commonly recommended, as it will cut through a greater amount of trash. The deep furrow drill is adapted in areas subject to wind erosion. This type of drill will operate in heavy residue and provides added wind-erosion control where crop residues are light.

The areas of low rainfall and light residues present no special difficulties in the residue management program except in seasons of abnormally high precipitation. Supplemental control sometimes is necessary during years of exceptionally light cover, and this usually is accomplished by contour strip chiseling or even solid chiseling, especially in heavy soil areas or where quick snow melt occurs while the ground is frozen. Basin listing may be applicable under these conditions, although the field of application is limited definitely to long slopes of low gradient.

The common practice under average conditions is to leave the stubble over winter, to plow in the spring with a modified moldboard plow or similar implement, and to follow with a rod weeder for weed control, limiting the number of operations to the absolute minimum. The rod weeder is the most adaptable and widely used weeding implement in the region; it has replaced the stationary rod and blade weeders because it will cultivate fallow with a heavy trash cover. It is also replacing the one-way for weeding operations because it leaves a more trashy, cloddy surface. The duckfoot is little used except for noxious weed control, the principal objection being that it is difficult to control on steep slopes and that the ridges and furrows left are bound to accelerate erosion except on moderate slopes where contour operation is possible. Modification of the ordinary duckfoot shovel in the form of a flat sweep, to accomplish subsurface tillage without ridging, is a promising development.

In seasons of extra heavy yields of residue, the operator must deviate from his usual practices and follow about the same schedule as outlined for the more humid areas. This will involve one fall operation with a disk or similar implement. In performing this operation, it is, or should be understood by the operator that any treatment of the straw after harvest will result in a decrease in the amount of crop residues.

In areas of heavy snowfall and drifting, uneven distribution and loss of moisture are highly probable if the standing stubble is disturbed. As to speeding up or retarding percolation of moisture, this fall operation may work both ways, depending on the physical condition and type of soil. If only the length of straw, not the weight, is the problem, it may be handled by spring disking to cut the straw in shorter lengths and thus prevent clogging of implements used for subsequent operations. The fact that plowing is not necessarily the first operation in the management of grain stubble is gaining recognition. Preparing the stubble for the plow or other initial tillage implement, so as to facilitate proper residue management, is becoming an established practice in many areas.

Having the straw spreader attached to the combine is the first step in residue management under all conditions. In areas where preservation of all available residue is as important for erosion control as it is in the areas of limited rainfall, the distribution and placement of the residue, through the use of the straw spreader, is of primary importance. Although the collection of chaff in dumps for use as stock feed is permissible, the bunching of the straw or failure to use the straw scatterer usually results in poor utilization.

Pasturing of stubble and crop aftermath is a common practice in semiarid wheat-growing areas. Where stubble grazing is practiced, however, unless definite control of grazing is enforced the erosion loss frequently is greatly in excess of the value of the pasturage obtained; and, because of the extreme seasonal variation, both in yield and in palatability of the aftermath, it is practically impossible to establish a standard of permissible intensity of use.

The development of a number of new implements is facilitating the program of tillage and residue management. To receive consideration, however, every new development must follow the principles and procedures described above, if it is to prove of practical use in the management of crop residues for erosion control.

Glimpses of the C.C.C. at work

Wire and brush dams facilitate gully control work.

Fences on the contour are vital features of the new farm programs.

C.C.C.–S.C.S. camps
th

on the land

Broad-based terraces are valuable in erosion control on sloping lands.

n maintenance of drainage ditches to allow
to flow freely to outlets.

Overflow pipe outlets from dams must be carefully laid to grade.

SOIL CONSERVATION STRENGTHENS CREDIT RATINGS

By A. G. BLACK [1]

FIFTY million dollars' worth of farm loan security washed or blown away each year—such is the estimated annual damage by erosion to farms on which the Federal land banks and the Land Bank Commissioner have mortgage loans.

Constant erosion by wind and water demands the attention of nearly every farmer who is trying to pay for his farm or add to his income by the use of credit. To this end our farm credit institutions are working with the Soil Conservation Service and other agencies of the Department of Agriculture to build and save soil.

Thousands of farmers with Federal land bank and Land Bank Commissioner loans are participating in soil conservation programs. Officials of the national farm loan associations and production credit associations are helping to arrange contacts between their members and the local soil conservation staffs. Soil conservation work is also being carried out on farms owned by the Federal land banks. All of our cooperative credit institutions can do much to encourage complete farm conservation plans including combinations of practices and measures for the control of soil erosion—field rearrangements, contour farming, terracing, grass and legume seedings, dams, and tree planting.

When a farmer makes a mortgage he assumes a risk. If the mortgage is on a farm subject to erosion he assumes a double risk. Several years ago one of the Federal land banks made a study of the relation between soils and credit. The bank found that the farmer on a "good-soil" farm usually pays out of debt. Where the soil is thin or badly eroded he is more often foreclosed and sold out. No group of farmers can lose more through soil erosion than those who are in debt. No group can benefit more through soil conservation.

The soil auger of the farm land appraiser has told the story many times. Five or six years ago appraisers for the Farm Credit Administration used soil augers in appraising nearly a million American farms. That was during the emergency program to refinance farm debts. What those soil augers showed about farm values was as important as the long-range prospect for prices of corn or cotton. Several hundred thousand applications were rejected. Soil erosion was more responsible for these rejections than any other one factor.

No indebted farmer, and no creditor institution can long afford to overlook the damage which erosion is constantly causing. Wind and water have no respect for prior liens. Some types of erosion are not visible to the untrained eye. Sometimes a farm loan breaks down before the real cause is discovered. Too much emphasis cannot be given to the need for close cooperation between the land banks and agencies of the Department that are administering programs to help farmers save soil and water.

More than a dozen years ago the Federal land bank of Houston became alarmed by the declining yields of cotton in the black-soil area of Texas. People had thought the soil of this area was inexhaustible. But declining farm income, difficulties in repaying loans, discouragement of farmers—all these factors pointed to the insidious effect of soil erosion and soil depletion. The Federal land bank and the Extension Service could do little more than make a start in aiding the owners of this land to check soil erosion and build up soil fertility. With the help of the Soil Conservation Service, farmers in one section of the Texas Black Belt have recently established the largest contiguous area of conservation-treated land in the United States. Here and in many other soil conservation districts throughout the country, farmers have a basis for credit, and a repayment ability, which they did not have before. The same comes from the assistance given by the A. A. A. program in saving the soil. All this conservation work has improved soil ratings. It has also improved credit ratings.

Soil conservation helps to stimulate good farming practices. It tends to cut down one-crop farming; it encourages diversification, such as cover crops, grazing, and livestock. Conservation has an effect on soils. It has an effect on people; the increased pride of ownership that comes from a well-kept farm is almost as important as the dollars and cents. This is another reason for believing that soil conservation will pay the indebted farmer a double dividend for his efforts.

(Continued on p. 308)

[1] Governor, Farm Credit Administration, Washington, D. C.

Millet stubble (left foreground) and millet stalks (center foreground) trace the line where mowing was stopped. The block of soil is about 700 feet from its original position. Part of the eroded area is discernible at the left.

OBSERVATIONS ON A FLOTATION TYPE OF EROSION IN THE CHENANGO VALLEY

By C. W. ROSE [1]

AN UNUSUAL type of erosion, which for the purpose of this discussion may be called flotation erosion, has been observed in lowlying areas or depressions in the Chenango River flood plains in Chenango County, N. Y. There is unquestionable evidence that from 4 to 6 inches of soil was removed, en masse, from some of these areas. The actual mechanics of its removal is a matter of conjecture. However, the circumstances prevailing at the time this erosion is known to have occurred, in the spring of 1936, strongly indicate that ice was the agent responsible for this heavy loss of soil.

The soil of the river flats is a dark brown silt loam at the surface with a light brown clay subsoil, and resembles Eel silt loam or Middlebury silt loam. When these depressions are plowed the soil is found to be granular and to have a high content of organic matter. It becomes very porous down to plow depth, but below this depth it is quite impermeable.

It appears that water, standing in these depressions in the fall, permeates the soil that has been loosened by plowing and covers it to a depth of several inches. Then, during the winter months, the porous water-soaked surface soil and the water in the depression become frozen into one cohesive mass. Perhaps at later times, during winter and early spring, more water drains into the depression and freezes to the original ice-and-soil mass. When the spring freshet occurs, and the whole flood plain becomes submerged under several feet of slowly moving water, the mass of ice, with its burden of soil attached to the lower side of it, is buoyed up and floated downstream.

On the farm of Robert Westover near Oxford, N. Y., an area of approximately 2 acres occupying the lowest portion of a depression was almost completely denuded of its surface soil by this type of erosion during the spring of 1936. An additional 3 acres of this depressed area was very spotted, due to removal of surface soil in some places, and its retention in situ in others. Two smaller areas, most of which had sod or swamp grass cover, were similarly eroded; and eight parallel strips, about 2½ feet wide, where the owner had burned windrows of hay late in the summer were almost completely denuded of surface soil. It appears that the burning materially weakened the sod.

The boundaries of all the eroded areas were in general very well defined with vertical sidewalls indicating that the surface soil had been picked up vertically, instead of having been washed away by the running water.

[1] Junior soil conservationist, Northeastern Region, Soil Conservation Service, Machias, N. Y.

The six-inch scale, standing on the original meadow sod, shows at least five inches of transported soil with a good sod cover.

The evidence supporting the theory of flotation erosion is conclusive. It consists of layers of seemingly undisturbed, though transported, soil ranging in thickness from 4 to 6 inches and in diameter up to 50 feet or more, found scattered along the river flood plains to a maximum distance of 1,500 feet downstream from their original positions. These blocks of soil had definite boundaries and were covered with millet stalks and stubble and, in some cases, grass sod. The stubble and sod invariably were found in an upright position with no deposition over them.

The largest eroded area is too wet normally for cultivation until midsummer, and for several years, including 1935, it had been cropped with millet. The owner, when he harvested millet in the fall of 1935, was unable to mow the northeast corner of the area because of excessive water. A distinct line of demarcation then existed, with millet stalks standing on one side and millet stubble on the other. After the 1936 spring freshet, a block of soil 50 feet in diameter with this same line of demaraction was found on a meadow about 700 feet downstream from its original position. Neither the millet stalks nor stubble appeared to have been disturbed. This recently deposited soil was removed in several places, and it was found to average about 5 inches in thickness. No difficulty was encountered in making this determination, as the meadow sod under the deposit was easily detected.

Blocks of superimposed soil were found scattered over the river flats for a distance of approximately 1,500 feet to a point where Bowman Creek enters the river from the north. Any blocks of ice and soil which reached this point probably were deflected into the main river channel by the faster moving water of the creek. No blocks were found below this stream.

Since flotation erosion is known to have occurred in several depressions in the flood plains of the Chenango River in 1936, it is reasonable to assume that it has happened many times in the past, and that under favorable weather conditions it may continue to occur in the future, not only along the Chenango River, but along many of the larger streams of the country when and where favorable climatic and soil conditions prevail.

First bottom soils, it would seem, may provide ideal conditions for the occurrence of flotation erosion, and it is not improbable that many flood-plain depressions have been formed or accentuated by repeated occurrences of the phenomenon.

ECONOMIC AND SOCIAL CONSIDERATIONS

(Continued from p. 287)

is pursued with the farmer, he should realize the validity of the new farm plan and proceed to put it into execution without mental reservation as to its desirability.

When the organization or combination of enterprises, land use, and practices that is considered best by both the technician and the farmer is arrived at, the program of conservation operations and the land-use map, setting forth the land use and practices as agreed upon, should be prepared

It is believed that the general procedure outlined herein has considerable merit. Through this method of procedure, both the farmer and the planning technician obtain a clear-cut inventory of the farm, and they are able to look at the farm from the same viewpoint. This method of approach should aid in speeding up the planning process, since the farmer is not placed on the defensive in attempting to safeguard his immediate income. Both the farmer and the farm planner are primarily interested in the best continuous utilization of the farmer's resources. Since the farmer assisted in formulating the plan and considered the alternative organizations suggested, as well as the organization that was finally adopted, he should realize both the physical and economic soundness of the plan, and should proceed without mental reservation in putting this plan into effect. It is believed, therefore, that such consideration will speed up the planning process and result in "sounder" plans, will reduce the time ordinarily required in assisting and encouraging the farmer in performance, and finally, will assure more effective application of the plan by the farmer.

FARM LABOR IN A SOIL CONSERVATION PROGRAM

By S. W. ATKINS [1]

SOIL and water conservation programs will affect farm labor chiefly as a result of shifts in crop and livestock systems and changes in structural control. For instance, the total amount of labor used and its distribution throughout the year will be affected by changes in acreage and/or the kind of crop. Any decrease in intensity of the cropping system will tend to decrease the total amount of labor. On the other hand, the amount of labor used will increase in certain circumstances because of maintenance labor required on such facilities as terraces, meadow strips, grassed waterways and pastures. Furthermore, the time used to perform certain field operations per acre of land will change as a result of changes in size and shape of fields through terracing and strip cropping and of such practices as contour tillage.

A study [2] in progress since January 1, 1937, in the Cedar Creek soil conservation demonstration project area, Franklin County, N. C., has been designed to determine in part the impact of the planned program of soil and water conservation on farm labor. This study is based on information obtained from daily labor records kept by farmers, from opinions of farmers, and from certain observations made in the field by research workers.

Changes in the cropping systems on farms under agreement with the Soil Conservation Service have not resulted in any significant change in the total amount of farm labor used on the representative farms studied. On 18 identical farms the estimated increase in the total amount of labor resulting from changes in number of acres in the various crops was slightly less than 10 percent, or a total of 42 man work units, during the first 3 years of the Soil Conservation Service program (table 1).

This net increase was caused by a shift of some cropland from cotton production to tobacco, a crop which uses considerably more labor per acre. This shift resulted chiefly from an increasing price advantage for tobacco rather than from the planned soil and water conservation program. Changes in the amount of labor used on other crops, such as corn, hay, seed, and crops for soil improvement, also resulted principally from changes in number of acres and kinds of crops.

TABLE 1.—*Man work units [1] per farm used in crop production on 18 identical farms before and after inauguration of the Soil Conservation Service program*

Crop	Man work units		
	Before (1935)	After (1938)	Change
Row crops:	*Units*	*Units*	*Units*
Corn	144	121	−23
Cotton	100	85	−15
Tobacco	177	256	79
All row crops	421	462	41
Small grain	4	2	−2
Hay	16	16	(2)
Cover crops for soil improvement	5	9	4
Seed	5	4	−1
Total [3]	451	493	42

[1] 1 unit equivalent to amount of work accomplished by an average farmer in this area in 10 hours.
[2] Less than 0.5 units.
[3] Normal work units per acre were used in calculating the total labor used.

An analysis of these changes shows that the small increases in quantity of labor used on cover crops for soil improvement were almost entirely offset by corresponding decreases in labor on small grain harvested and on seed crops. Labor on seed crops declined, notwithstanding the increase in number of acres. This decrease in labor was a result of a shift from the production of cowpeas for seed to lespedeza for seed; lespedeza requires relatively small quantities of labor per acre. For like reason the shift from cowpea hay to lespedeza and meadow-strip (grassed-waterway) hay resulted in no significant increase in total amount of labor used, although the acreage of hay was expanded.

Case studies of proposed conservation programs on farms representing the two major types of farming in this area indicate that slightly less labor will be used under the proposed plan than was used under the original plan (table 2). This is assuming, of course, that the conservation programs are carried out as planned. Insofar as crops are concerned on these case farms, reductions in the amount of labor will result principally from a shift to crops having relatively low

[1] Associate agricultural economist, division of economic research, Soil Conservation Service, Raleigh, N. C.

[2] Cooperative with the North Carolina Agricultural Experiment Station, the Soil Conservation Service, and the Bureau of Agricultural Economics.

labor demands per acre, and from a small reduction in acreages of corn and cotton. The combined reductions in the amount of labor used are offset only in part by increases in the amount used for small grain and for cover crops. Changes in labor used on livestock are not likely to be significant in the area, according to indications on these case farms which are fairly typical of the area in this respect. Expected increases in labor used on pasture maintenance will be offset in part by reduction in chore labor because of greater convenience, for the most part, in handling newly established permanent pastures.

TABLE 2.—*Man work units ued on 2 representative farms under original and proposed farm plans*

Item	Tobacco-cotton farm		Cotton farm	
	Original	Proposed (S. C. S.)	Original	Proposed (S. C. S.)
	Units	*Units*	*Units*	*Units*
Row crops	427	413	108	99
Grain [1]	2	17	0	0
Hay	14	8	4	5
Cover crops for soil improvement	4	[2] 1	0	6
Seed	25	[2] 15	9	0
All crops	472	454	121	110
Pasture maintenance	0	2	0	1
Livestock	50	57	27	27
Total	522	513	148	138

[1] Grain harvested with combine.
[2] Labor on lespedeza was included only in the seed crop group, although this crop is also used as a soil-improving crop after the seed is harvested.

Maintenance of structural erosion-control facilities under the Soil Conservation Service program will result in little, if any, change in amount of farm labor used on the average farm.[3] Farmers' opinions indicate that the amount used on maintenance of terraces increased on about one-third of all farms reporting and decreased on other farms reporting (table 3). A much smaller proportion—about one-eighth—reported increases in the amount of labor used in maintenance of terrace outlets, including meadow strips or grassed waterways.

These opinions are corroborated by observations of research workers and by related data. For example, terracing was practiced on approximately 90 percent of the farms in the area prior to the establishment of the Soil Conservation Service program. According to reports from cooperating farmers, their old terraces were damaged much more frequently by heavy rains than were terraces constructed by or under the supervision of the Soil Conservation Service. These old terraces actually use more maintenance labor, in terms of repair work on breaks than do terraces of approved specifications. Furthermore, on meadow strips little or no maintenance labor is used other than that chargeable directly to the hay crops commonly harvested from these strips.

[3] It is recognized that labor used in establishing structural erosion-control facilities often involves relatively large quantities of labor and power. Since this type of work on demonstration farms was done in part by the Soil Conservation Service, the burden on farm labor resources was greatly relieved. Without this assistance the accomplishments on many farms necessarily would have been distributed over a longer period of time.

TABLE 3.—*Farms reporting specified changes in amount of man labor used for terrace and terrace-outlet maintenance as a result of the Soil Conservation Service program*

Item	Number and percent of farms			
	Terraces		Terrace outlets	
	Number	Percent	Number	Percent
All farms reporting	44	100	42	100
Farms reporting increase	16	36	5	12
Farms reporting decrease	28	64	36	86
Farms reporting no change	0	0	1	2

Cooperating farmers generally believe that such Soil Conservation Service practices as terracing, contour tillage, and strip cropping have not materially increased the amount of labor used per acre of land. Of 47 farmers reporting, more than 90 percent expressed the opinion that the labor used per acre had not changed for such operations as breaking, harrowing, cultivating, and mowing. Data on farm labor, collected from daily labor records, show little difference in amount of labor used per acre on important field operations on cooperating and noncooperating farms (table 4). Only in cultivation was there a noticeable difference between the two groups in amount of labor used per acre. The few operators who reported a larger amount of labor used per acre thought that shorter rows was the major causal factor. It is probable that this factor was responsible, in part, for the higher average hours per acre used in cultivation, as shown in table 4. Because of the greater number of times the operation was performed, any increase in labor per acre would tend to be greater than on operations requiring less frequency of performance, such as running rows and distributing fertilizer.

That the program of the Service has had little effect on labor used per acre is to be expected. On a large proportion of farms, small irregularly shaped fields predominated prior to initiation of the program, and they were not changed greatly by the terracing and

TABLE 4.—*Hours of man labor per acre reported by 14 cooperating and 25 noncooperating farms, 1937, in performing specified operations on corn, cotton, and tobacco* [1]

Operation	Cooperating farms	Noncooperating farms
	Man labor hours	*Man labor hours*
Flat breaking, 1-horse	10.0	10.0
Flat breaking, 2-horse	7.0	7.2
Bedding, 1-horse	6.9	7.1
Running rows, 1-horse	1.8	1.9
Distributing fertilizer, 1 horse	2.1	2.0
Listing, 1-horse	3.9	3.8
Planting, 1-horse [2]	2.0	2.0
Cultivating, 1-horse	17.5	16.2

[1] Averages for each crop were analyzed separately by operations. Differences between crops, for purpose of comparing cooperating and noncooperating farms, were not significant.
[2] Cotton and corn only.

strip cropping recommended. Research data, collected in this area, indicate however that an increase in amount of labor used per acre will likely occur on farms on which the conservation program has caused a decrease in size of fields and/or made fields more irregular in shape.

Distribution of labor throughout the year on farms in this area is generally characterized by high peak demands during certain periods and by very low demands during others. On tobacco farms these peak labor loads normally occur during planting, harvesting, and grading seasons. On cotton farms peak loads occur normally during cultivating and picking seasons. On both types of farms there are periods when the available labor resources normally are not utilized productively, while during other periods labor demands exceed the normal available labor supply. Deficits in normal labor available at peak labor loads are commonly supplied by exchange labor, by labor of women and children, and by working longer hours.

Planned cropping systems inaugurated on farms under agreement with the Soil Conservation Service will tend to improve labor distributions on both tobacco and cotton farms in this area. A comparison of labor distributions on a tobacco and cotton farm prior to and under the Service program shows that the proposed cropping systems tend to decrease the former peak loads and to increase the amount of labor used during the previous low points in the labor distribution. Peak loads are reduced under proposed plans partly as a result of a decrease in cotton acreage and further as a result of shifts from cowpea and soybean hay to lespedeza hay. Not only is it true that lespedeza demands less labor per acre, but it is also true that the labor used in preparation and seeding in early spring does not conflict so seriously with other farm labor as does labor used on cowpeas and soybeans. Terraces and other structural maintenance practices are also using available labor during slack periods. Fall seeding of winter cover crops and fertilizing of pastures, meadow strips, and small grain in early spring, are also being done on these farms during periods of normally low labor use. However, some resistance to seeding early fall crops exists, because of possible conflict with grading tobacco and picking cotton. These crops frequently are rushed to market to supply badly needed operating capital, but many farmers are readjusting their operations to allow for time necessary to make fall seedings without seriously delaying fall harvesting and marketing operations. Apparently, these readjustments will be made on an increasing number of farms as farmers learn to "live with" the new program.

The changes in labor resulting from planned programs of the Soil Conservation Service have not been marked to date, nor will they likely be reflected in significant increases in cash expenses for labor, as far as this area is concerned. Only about one-tenth of all farm labor is represented by wage labor and even some wage laborers are paid in part with a share of the crop. Nine-tenths of the labor is performed by operators, operators' families, and sharecroppers. Exchange labor is common during peak labor loads and is usually performed by operators and their families. Under present share-crop contracts, croppers absorb any increase in the amount of labor used per acre of land caused by terracing, strip cropping, and contour tillage. Some farmers hire extra labor—often their sharecroppers—to seed winter cover crops. On the majority of farms, however, labor involved in production of extra crops and such maintenance work as is done on terraces, pastures, and terrace outlets can be done by the regular labor supply with little or no cash outlay for labor. This is made possible chiefly by the distribution of the extra labor which does not seriously conflict with the regular labor. On most farms a surplus of regular labor, which has few or no productive alternative opportunities, is available in slack periods. Based on the above, the "additional labor bugaboo" cannot offer any hindrance to the initiation and operation of a definitely planned program of soil and water conservation on farms in this area.

The Soil Conservation Service has announced that 8,500,000 acres of land in 141 land utilization projects established since 1933 will be opened for free public use for hunting, fishing, and trapping.

ORCHARD DISK ESPECIALLY SUITED TO CONTOUR PLANTING

By HENRY CLAY LINT [1]

PEACH orchards in the Coastal Plain section of New Jersey are generally clean tilled during the summer months. The practice most frequently recommended consists of seeding the orchard to a vetch and crimson clover mixture about the middle of August. Such a cover is allowed to remain until late April or even late May, depending on the amount of moisture in the soil.

Under some soil conditions, the planting of alternate middles to perennial leguminous cover has worked out satisfactorily in peach orchards, but clean cultivation during the summer is standard practice and the evidence and experience indicate that it is likely to continue. Terracing and contour cultivation therefore naturally suggest themselves as a means to erosion control during this period of the year when there is no cover in the orchard.

In starting a new peach orchard, it is imperative that the young trees be clean cultivated, and one of the objections to contour planting is that the one-way cultivation necessitates hand work in eradicating weeds between trees in the rows. A strip of mulch about 5 feet wide has been used for this purpose, with varying degrees of success. Some plantings will come through with a minimum of weed growth, but others under different conditions show that no practical amount of mulch is effective in inhibiting weeds.

A solution to the problem of weed elimination in the tree row between trees appears to have been found through the use of an implement known locally as a grape-hoe. It is simply a V-type cultivator which has hinged behind it a straight coulter equipped with a single handle with which the operator steers the cultivator much as he would manipulate the tiller on a boat. By attaching the grape-hoe to the extreme end of a disk harrow, the operator is able to cultivate the space in the tree row between trees, and by using the steering lever he is able to miss the trees. With this implement it is possible to cultivate out practically all weeds.

The disk, developed by Messrs. Nocenti, Hubbard, and Granholm of the Moorestown staff, is an adaptation of the old extension cultivator developed as long ago as 1913 in New Jersey by Prof. A. M. Blake. It is an effective cultivator, capable not only of maintaining but also in the upbuilding of tree-row berms. Our experience with starting a new orchard on our light sandy soils indicates that the berms should be built up as the tree roots spread out, and that best growth is most likely where the trees are planted with backfurrows to aid in bringing the moisture supply near to the tree roots.

The ordinary farm disk as it is used in orchards is not effective in building up a berm on the tree row; in fact backfurrows or even small terraces are likely to be destroyed by the ordinary disk. It was to overcome these difficulties that an Oliver orchard disk was reconstructed so that in its operation all movement of the soil would be from the center of the tree middle toward the tree; with both gangs set to throw out, they merely were spaced 5 feet apart. To understand its operation, imagine tree rows 20 feet apart and assume that the space is to be divided into 4 strips, A, B, C, and D, each 5 feet wide. On one trip through the orchard, strips A and C are cultivated; on the next trip, areas B and D are covered. In actual practice, contour rows are not everywhere parallel so that it may be necessary sometimes to go down the tree middles with an ordinary disk to cultivate out some small islands left by this orchard disk.

The effectiveness of the new-type orchard disk is indicated by comparison with an ordinary farm disk and plow in the following table:

Terrace number	Percent slope of land above terrace	Terrace channel cross section			
		May 17	June 18	July 18	August 15
	Percent	*Sq. feet*	*Sq. feet*	*Sq. feet*	*Sq. feet*
1	6.20	2.79	.58	2.05	4.04
2	8.06	3.94	.34	1.51	2.62
3	6.53	4.29	.54	3.37	5.91
4	5.44	2.91	.83	2.54	5.91
5	4.67	5.50	.88	3.85	8.67
6	1.37	13.46	1.39	3.68	10.98

May 17. Backfurrow only 2 rounds with 14-inch plow.
June 18. After 3 cultivations with ordinary farm disk.
July 18. After 2 cultivations with orchard disk.
August 15. After 6 cultivations with orchard disk.

The orchard was planted in the spring of 1938 and backfurrows were thrown up at that time. In the fall

[1] Project manager, Northeastern Region, Soil Conservation Service, Moorestown, N. J.

Type of "grape-hoe" used in contour orchard cultivation.

of 1938, the terrace outlets were seeded. To prevent concentration of water in the outlet, the backfurrows were deliberately knocked down when the winter cover was seeded. New backfurrows were thrown up in the tree rows about May 1, 1939, but the stand of vetch and crimson clover was left intact between the plowed areas until about May 15, when it was disked to kill the cover crop. A series of elevation readings was made over 6 rows just before the first disking and permanent bench marks were installed as it was expected that the development of these terraces would be studied over several years as the thesis of an evaluation survey.

The cross-section data of May 17 therefore represent the terrace channel capacities resulting from the backfurrows alone. During the following month, the grower cultivated three times on the contour with an ordinary four-gang disk, and how thoroughly the backfurrows were torn down is shown by the relative capacities on June 18. Between June 18 and July 18, the farmer cultivated twice with the orchard disk, and the cross section on the latter date shows to what extent the disk was successful in again building up the berms. Between July 18 and August 15 four additional cultivations were made, so that the final capacities shown are the result of six diskings.

In securing the data for the cross sections, an instrument was developed which enables obtaining elevations to 0.01 foot at horizontal intervals of 0.1 foot very quickly. A straight piece of lumber 2 inches by 3 inches by 12 feet is marked at 0.1 intervals. Supports are provided to maintain this instrument level with the ground surface when measurements are taken in the field. A carriage slides along the straight piece of lumber and a weight suspended by a string is dropped until it just touches the soil. The other end of the string is tied to a sliding scale and the readings can be made direct. It will be understood, of course, that the high point of a berm may consist of far too little soil to enable the berms actually to hold as much water as the cross-section area would indicate. All measurements were made over exactly the same course, in a straight line between the top and bottom bench marks. It so happens that the line selected is at a fairly sharp curve in the terrace berms. It was observed that the disk was even more effective on the straightaway portions of the berms than at the place where the cross-section data were taken.

A study of the cross section shows that the increased capacity is due to a lowering of the channel or space in the tree middle rather than to raising the height of the berm. The latest cross-section measurements indicate the development of a true terrace with the low point of the channel 7 to 12 feet above the berm instead of about 3 feet as was the case with only backfurrows.

While the results obtained by using this type of disk are all that could be desired, the implement has one serious fault in that all of the end thrust is borne by the bearing boxes, thus causing both boxes and the spacer spools to wear fairly rapidly. Several ways of overcoming this difficulty have suggested themselves and once this is worked out there should be little difficulty in convincing farmers of the importance of converting their own disks along these lines. The only new materials required for changing present types of farm disks to this new one are two angle irons 3½ inches by 3½ inches by ⅜ inch.

Pasture Treatment in the Ohio Valley

On the Leatherwood Creek project near Bedford, Ind., farm records secured by Marion M. Merritt and J. M. Rudy show that several farm pastures treated with 1½ and 2 tons of lime and 400 pounds of superphosphate (20 percent) per acre, produced about twice as much forage as similar pasture land that was not treated. Records were kept on 6 farms in 1938 and on 12 farms in 1939. The increased returns nearly paid for the lime and fertilizer the first year. Another application will not be needed for 3 to 5 years. Such treatment of poor pastures is justified also because it makes possible a thicker cover of vegetation to reduce soil losses and run-off, provides a more nutritious feed, and encourages farmers to keep more of their land in grass. More details of this are reported in Regional Circular 188, Dayton, Ohio, April 25, 1940.—A. T. Semple.

A MODIFIED MOWER FOR LEAVING HIGH STUBBLE

By HUGH G. PORTERFIELD [1]

ON much of the severely eroded cultivated land and the denuded ranges in the Dust Bowl the establishment of cover crops is necessary to prevent further erosion and to furnish protection for the grass seedlings in their first growth periods. In the beginning stages of the revegetation program in this area it was apparent that a mower was needed that would (1) cut stubble covers from ground level to at least 16 inches in height, and (2) mow weeds and sorghum covers on listed fields on which the ridges were not worked down. Such mowing operations would permit the testing of the erosion resistance of covers cut at various heights in preparation for grass seedings, and also the effect of different heights of stubble in obtaining and maintaining grass stands when residue is allowed to remain on the ground. A mower that would meet all the needs for experimental or field work was not available at the beginning of the revegetation program. Most of the regular stock mowers will cut only up to approximately 8 inches in height, and they will not operate satisfactorily over lister ridges.

A mower having a wide range of uses in cutting various cover crops has been developed on the Dalhart research project. One of the chief values of this machine is that it has a cutting range varying from ground level to 16 inches in height. It has proved satisfactory for mowing weeds on deep-listed land as well as sorghums planted with a lister and allowed to mature without cultivation.

The following changes or adjustments were made:

1. The "lifting chain eye bolt" of the usual mower is made of high carbon steel and often breaks from vibration and "whip" of the cutter bar when mowing over 6 inches in height. This piece of high carbon steel is replaced on the modified machine by a piece of malleable iron rod at a cost of 30 cents, and thus the abovementioned defect is eliminated.

2. The tractor hitch should be approximatey 2 feet from the ground and this necessitates that it be raised or that a supplemental hitch be used. This modification adds height to the front of the mower and keeps the protective case and shoe for the pitman from dragging in lister ridges.

The modified mower cutting standard broomcorn cover approximately 16 inches high, in preparation for spring grass seeding. Observe the height at which the mower is hitched on to the tractor. Amarillo Experiment Station, Sand Dune Stabilization and Revegetation Sub-Project, Dalhart, Tex.

3. The mower tongue is shortened approximately 18 inches and the spring release hitch is discarded to make a solid strap-type hitch on the mower tongue. This is an aid in obtaining height for the front of the mower.

4. The cutter bar is reset for level and tilt. Until after the first few settings, this is mostly a matter of trial-and-error adjustment.

It seems apparent after inspecting several different makes of mowers that any of them could be adapted to the work with practically these same changes. The modified mower, cutting at a height of 16 inches, may be pulled at the regular speed behind a tractor without damage. In crossing road ruts and other extremely rough places it is advisable that the cutter bar be raised to an upright position.

NOTE.—Acknowledgement is made to B. F. Barnes, United States Dry Land Field Station at Dalhart, Tex., and to Charles J. Whitfield, Soil Conservation Service, Amarillo Tex., for suggestions in this work.

More and more, farmers are learning that systematic maintenance work is essential for satisfactory functioning of terraces. Soil Conservation Service projects continue to emphasize the need for this work and to demonstrate proper methods.

[1] Assistant soil conservationist, Amarillo Conservation Experiment Station, Soil Conservation Service, and Texas Agricultural Experiment Station cooperating, Amarillo, Tex.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

TERRACE OUTLETS AND FARM DRAINAGEWAYS. By C. L. Hamilton. U. S. Department of Agriculture Farmers' Bulletin No. 1814. 1939.

This publication has been in use for some months. However, for the benefit of those not yet acquainted with the newest and best available information on the construction, use and maintenance of surface run-off disposal measures required in upland or rolling terrain, it is reviewed here with special attention to details. The bulletin is a logical follow-up of Mr. Hamilton's earlier work on terracing for soil and water conservation, published in May 1938. "Terrace Outlets and Farm Drainage-ways" is a constructive piece of work; it goes directly into what to do and how to do it, for maintenance of effective run-off control on sloping farm land.

In the beginning the author points out that one or more soil-conservation practices, such as crop rotations, plant cover, strip cropping, contour tillage, diversion ditches, and terracing, will provide adequate protection to farm land if outlets and drainageways are properly constructed and protected. Stabilized drainageways are necessary, and natural depressions protected by the original vegetation are emphasized as most important in surface-drainage systems. But so many natural drainageway systems no longer function for safe and effective disposal of excess run-off—and hence this bulletin describing tried and approved treatments for drainageways on terraced and unterraced farm land.

Planning the run-off disposal system comes first in establishing soil-conservation measures, according to the author, whether the area is terraced or unterraced. "Many * * * individual drainageways that result from haphazard planning cannot be utilized efficiently when additional conservation measures are established, and they may even hinder the use of subsequent conservation practices." The planning of a drainage system according to the drainage unit is described as a careful observational study of a farm with special attention to surrounding fields and topographical features such as depressions, laterals, ridges and slopes, and with special consideration for proposed or existing soil-conservation practices. Unterraced areas are discussed with regard to grassed drainageways in natural depressions where land is used for crops, areas of rolling relief and branching watersheds, and land being retired to permanent cover.

"The cost of terrace construction and the success of the terraces are dependent upon the proper planning of outlets." Hence, the greater part of this bulletin is devoted to the planning and construction of economical and practical outlets for proper disposal of run-off from terraced areas. For the purpose of planning, outlets are classified as follows: (1) Grassed or wooded individual outlets; (2) meadow or pasture strips; (3) grassed channels; (4) channels protected by mechanical structures. In a detailed discussion of outlet types, the author points out various conditions which must be thoroughly considered in making preliminary plans, such as topographic features, size of fields, the grade and stability of natural drainageways below the outlets, local rainfall intensities and distribution.

For determining the hydraulic principles necessary for the design and construction of outlet channels, three tables are here shown which greatly simplify computations. Table 2 gives maximum run-off to be expected once in 10 years from drainage areas of 1 to 300 acres on rolling and hilly timber land, rolling and hilly pasture, rolling and hilly cultivated land, and rolling cultivated terraced land. Table 3 gives approximate dimensions of outlet channels with grass covers capable of resisting maximum average channel velocities of 5, 6, or 7 feet per second, with 4:1 side slopes and with good channel conditions. Table 4 shows the approximate discharge capacity of rectangular notches in small check dams. These tables are said by the author to be sufficiently accurate for all practical purposes.

The latter part of the bulletin is given over to the grading of drainageways, the alinement of terraces and outlets, methods of establishing vegetative cover in outlet channels or drainageways, and construction of mechanically protected outlets. It is pointed out that a satisfactory water-disposal system on the farm or watershed requires considerable attention not only in its planning and construction but in its maintenance. Frequent inspection and repair are emphasized as necessary to prevent cutting, silting, or damage to vegetation or structures.

THE MANAGEMENT OF FARM WOODLANDS. By Cedric H. Guise. New York, 1939.

Some of the workers in the Service and many cooperating farmers may not have discovered this book, although it made its first appearance some 5 months ago. The volume is good reading as well as an excellent beginning text on the management of small and large farm woodlands for maximum advantage and protection. Farmers will be especially interested, as the author has used a somewhat new approach in treating woodland problems—he has given life to his tree communities by presenting early in the volume a chapter on the physiology of trees, and another, immediately following, on the ecology of farm woodlands. In this part of the book in particular, and to some extent throughout, Mr. Guise displays an unusual talent for integrating the scientific and technological knowledge of woodlands with the social and economic requirements.

Some 80 pages are devoted to methods of estimating and calculating volumes, yields, and growth values of trees and woodland stands. The Doyle, Scribner, and the International log-rule tables are explained and compared, and formulas are given for making deductions for defects, for obtaining tree diameters, heights, wood content, and increment percentages. The surveying and mapping of larger woodland properties is included in this section of the book.

The latter half of the text consists of a description of the approved silvicultural practices for improving, planting, protecting, and

BOOK REVIEWS AND ABSTRACTS continued

utilizing tree stands whether small farm woods or tree plantations. In a chapter on care and improvement of woodlands, timber cutting for thinning or pruning is treated with considerable attention to detail, and another chapter dealing with farm-woodland protection explains quite thoroughly the best means of minimizing damage to stands through grazing, fires, insect and fungus pests, and tree diseases. Logging and seasoning of lumber are treated briefly, but a detailed chapter on wood preservatives makes this part of the book particularly useful to farmers who have stands of the less durable woods that could be used for farm-building construction, posts, etc., if properly treated against decay-producing forces.

The last chapter consists of a very lucid discussion of a workable farm-woodland management plan designed to protect the forest and the forest soil by proper cutting and planting practices, and to maintain a steady net income in return for labor and ingenuity and actual cost expended in a systematized plan carried out in detail. The book is well illustrated and contains many tables and charts of actual use in managing farm woods. Although examples pertain chiefly to woodlands of the eastern part of the United States, the principles of management are such that they can be applied throughout the country with details varying in different geographic and ecological sections. A list of selected references is included for those desiring more detailed knowledge on specific phases of forest and farm-woodland management problems.

THE "WHEELS" OF EROSION

(Continued from p. 289)

they do come to rest they play, with remarkable fidelity, the roles of pebbles, cobbles, or boulders in a place where genuine cobbles are infrequent and true boulders quite unknown.

It is natural for the soil conservationist to ask what can be done about this type of transportation. Field observations indicate that mud balls are always large in relation to the average size of the particles which form the stable bed of the stream in which they are formed, and that balls more than a foot in diameter are quite rare. If the balls investigated are typical, these large specimens may be counted on to break if they are dropped 8 inches, and those which are 8 inches in diameter will break when dropped 1 foot. A ball 4 inches in diameter will break if dropped 4 feet, and a 16-foot drop will ensure the destruction of a 2-inch ball. Apparently if the diameter is halved, the drop must be multiplied by four.

It would seem, then, that almost any drop such as occurs at a soil-saving dam may be expected to break all the larger balls, and the fragments can be prevented from re-forming into smaller balls if the channel bottom is artificially roughened downstream. In channels where no drop structures are present or contemplated, much could be accomplished by providing obstacles downstream from the chief clay sources so that incipient balls might be broken through impact. Two advantages are gained by reducing the size of the clay masses: (1) The fragments encounter only those lower velocities which prevail close to the streambed, thus the rate of transportation is slowed down, and (2) the mean size of the pebbles which may be carried away is reduced. In addition, the normal channel roughness becomes proportionally greater and is more effective in preventing the smaller clay chunks from rolling freely. This hinders the development of the high sphericity which is essential for the most efficient transportation of bedload materials.

CREDIT RATINGS

(Continued from p. 298)

All the Federal agricultural agencies are working to help conserve basic farm assets and to add to farm security. Farm Credit does this by saving the farmer on his interest costs. Other agencies help to save soil assets—to keep them from being washed or blown away. The individual farmer who is trying to save money by obtaining farm credit at a low cost, and also trying to conserve his primary investment, his soil, is making use of both types of public services.

The new hydraulic laboratory of the University of Minnesota will be used for investigating erosion-control structural designs in accordance with recent arrangements for cooperative research work between the Service and the University. This is one of the largest hydraulic laboratories in the world, with a 50-foot maximum head of water and housing a 200-foot flume 6 feet deep and 9 feet wide with a capacity of 300 cubic feet per second.

U. S. GOVERNMENT PRINTING OFFICE: 1940

SOIL CONSERVATION

Index

VOLUME V

July 1939 to June 1940

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1940

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION—INDEX TO VOLUME V

JULY 1939 TO JUNE 1940

248730—40

Chemistry of Soils Among Subjects Discussed in Recent Publications

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information United States Department of Agriculture

The Behavior of Boron in Soils. Technical Bulletin No. 696. Bureau of Plant Industry. December 1939.
Care of Ornamental Trees and Shrubs. Farmers' Bulletin No. 1826. Bureau of Plant Industry. November 1939.
Erosion and Related Land Use Conditions on the Lake Michie Watershed, near Durham, N. C. Soil Conservation Service. January 1940. 15¢.[1]
Erosion and Related Land Use Conditions on the Lloyd Shoals Reservoir Watershed, Georgia. Soil Conservation Service. January 1940. 35¢.[1]
Farm Fences. Farmers' Bulletin No. 1832. Bureau of Agricultural Chemistry and Engineering. January 1940.
Honey and Pollen Plants in the United States. Circular No. 554. Bureau of Entomology and Plant Quarantine. February 1939.
Putting Down and Developing Wells for Irrigation. Circular No. 546. Soil Conservation Service. February 1940.

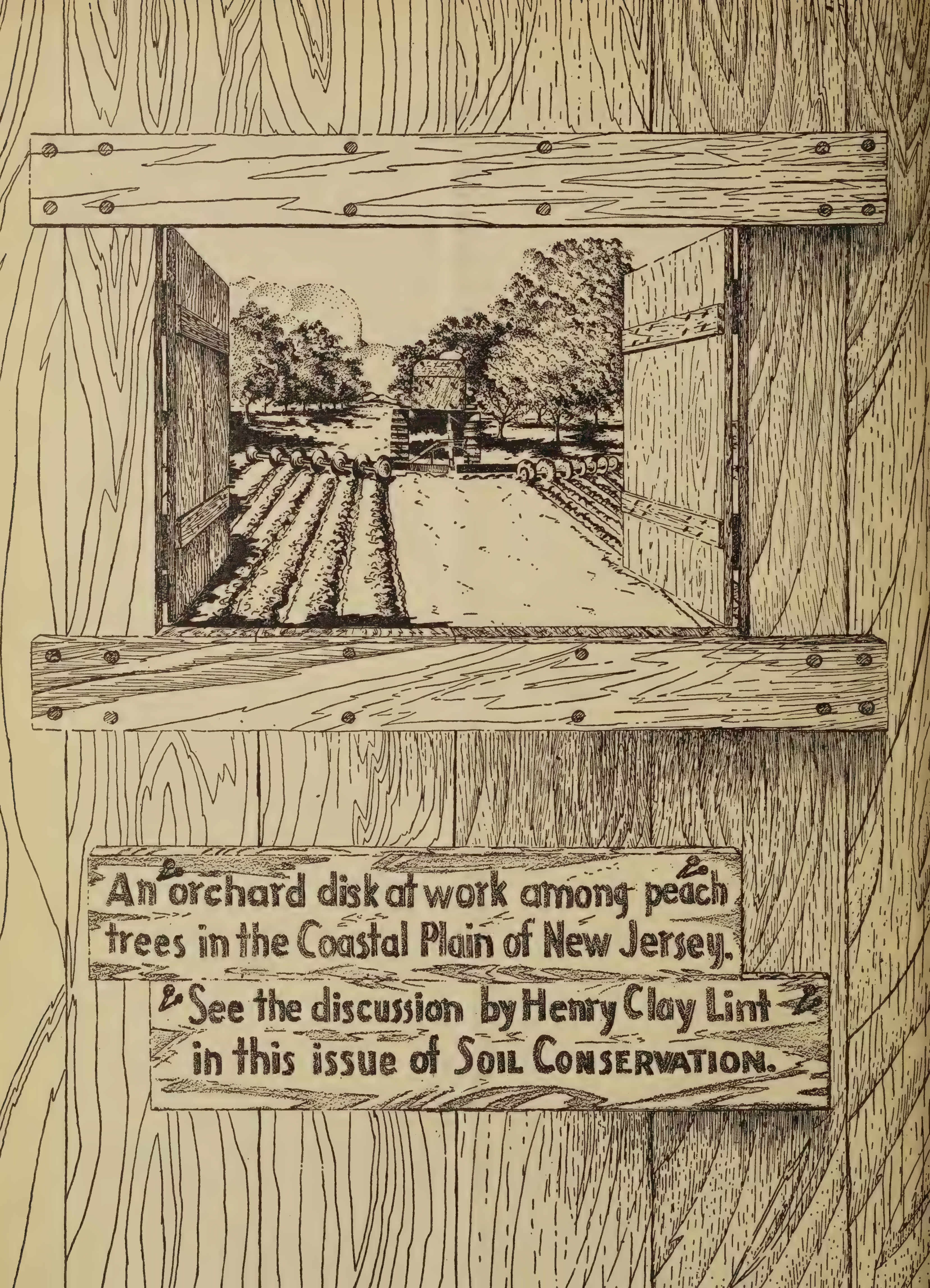
Agricultural Experiment Stations

Adjusting Farm Management to Changing Economic Situations. Bulletin No. 274. Agricultural Experiment Station, Rhode Island State College, Kingston, R. I. August 1939.
Agricultural Research for Mississippi Farmers. Special Bulletin Agricultural Experiment Station, Mississippi State College, State College Miss. December 1939.
Basic Data for Land Classification. Bulletin No. 232. (Idaho Works Progress Administration). Sponsored by Agricultural Experiment Station, University of Idaho, Moscow, Idaho. December 1939.
The Chemical Composition of Forage Grasses of the East Texas Timber Country. Bulletin No. 582. Agricultural Experiment Station, College Station, Tex. March 1940.
Corn Production on the Hill Lands of Louisiana. Circular No. 26. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Stations, University, La. March 1940.
Corn Yield Test, 1939. Bulletin P2 (new series). Agricultural Experiment Station, Iowa State College, Ames, Iowa. February 1940.
Effect of Shade on Pasture. Circular No. 65. Agricultural Experiment Station, University of Tennessee, Knoxville, Tenn. December 1939.
Farm Management and Cost Study on 500 Family-Sized Farms in the Louisiana Sugar Cane Area, 1938. Bulletin No. 314. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Stations, University, La. February 1940.
Kudzu: Its Value and Use in Alabama. Circular No. 83 (revision of circular No. 57). Agricultural Experiment Station, Alabama Polytechnic Institute, Auburn, Ala. December 1939.
Land Tenure in Arkansas. I. The Farm Tenancy Situation. Bulletin No. 384. Agricultural Experiment Station, University of Arkansas, Fayetteville, Ark. January 1940.
Progress Report of Phosphate and Other Fertilizer Investigations at the Aberdeen Branch Experiment Station, University of Idaho. Bulletin No. 230. Agricultural Experiment Station, University of Idaho, Moscow, Idaho. October 1939.
Range Resources of Rich County, Utah. Bulletin No. 291. Agricultural Experiment Station, State Agricultural College, Logan, Utah. March 1940.
Range Sheep Production in Northeastern Nevada. Bulletin No. 151. Agricultural Experiment Station, University of Nevada, Reno, Nev. January 1940.
Report of the Hawaii Agricultural Experiment Station, 1939. University of Hawaii, Honolulu, T. H. March 1940.
A Report of Phosphate Investigations in Montana for 1939. Bulletin No. 378. Agricultural Experiment Station, State College, Bozeman, Montana. February 1940.
Report on Agricultural Research for the Year Ending June 30, 1939. Part II, Iowa Corn Research Institute Fourth Annual Report. Agricultural Experiment Station, State College, Ames, Iowa.
Research in Agriculture: Work of the Agricultural Experiment Station During the Year Ending June 30, 1937. Bulletin No. 413. Agricultural Experiment Station, University of Missouri, Columbia, Mo. January 1940.
Results of Cotton Variety Tests, 1936–1939. Bulletin No. 204. Georgia Experiment Station, University of Georgia, Experiment, Ga. February 1940.
Some Results of a Farm Management Survey in Rapides, Union, Claiborne, and DeSoto Parishes, 1938. Bulletin No. 317. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Stations, University, La. March 1940.
Sorghum in North Georgia. Circular No. 121. Agricultural Experiment Station, University of Georgia, Experiment, Ga. February 1940.
Suggestions for Increasing Corn Yields in Central and South Louisiana. Circular No. 23. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Stations, University, La March 1940.

Miscellaneous

Analysis of the Present Program of Research in the Economics of Soil Conservation and Suggestions for Its Improvement. Bureau of Agricultural Economics, U. S. Department of Agriculture. March 1940. mm.
The Construction, Operation, and Use of the North Fork Infiltrometer. Flood Control Coordinating Committee Miscellaneous Publication No. 1. California Forest and Range Experiment Station, Berkeley, Calif. February 1940.
Farm Operating Efficiency Investigations in Virginia, 1931–1938. Progress Report. Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, and Virginia Polytechnic Institute, Blacksburg, Va. 1940.
Operation of Agricultural Conservation Programs in Illinois. Farm Management Reports No. 4. Bureau of Agricultural Economics and Agricultural Adjustment Administration, U. S. Department of Agriculture, cooperating with Illinois Agricultural Experiment Station. January 1940. mm.
Plan Wisconsin Pastures. Circular No. 298. Extension Service, University of Wisconsin, Madison, Wis. March 1940.
Report of the Central States Forest Experiment Station, 1938–1939. (Not for publication.) Central States Forest Experiment Station, Columbus, Ohio. mm.
Safe and Sound Cotton Farming in Tennessee. Publication No. 229. Agricultural Extension Service, University of Tennessee, Knoxville, Tenn. November 1939.
Safeguard the New Seedings. Circular No. 300. Extension Service, University of Wisconsin, Madison, Wis. April 1940.
Save Plant Food in Manure. Circular No. 296. Extension Service, University of Wisconsin, Madison, Wis. February 1940.
Soil Building Practices in the 1940 Agricultural Conservation Program. Ohio State University, Columbus, Ohio.
Rural Rehabilitation Progress in Stearns County, Minnesota. Farm Management Reports No. 3. Bureau of Agricultural Economics and Farm Security Administration, U. S. Department of Agriculture, in cooperation with Minnesota Agricultural Experiment Station. March 1940. mm.

[1] From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.


An orchard disk at work among peach trees in the Coastal Plain of New Jersey.
See the discussion by Henry Clay Lint in this issue of SOIL CONSERVATION.